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PRELIMINARY NOTES ON THE DEPTH OF HIBERNATION OF WIREWORMS (*ELATERIDAE, COLEOPTERA*)

By J. W. McCOLLOCH, WM. P. HAYES and H. R. BRYSON[1]

ABSTRACT

Since little is known concerning the hibernation of wireworms which pass the winter in the larval stage under the surface of the soil any observations, however meager, are of value in working out the complete life history of these important, injurious insects. Preliminary studies carried on in Kansas consisted of a series of diggings mostly in uncultivated areas where wireworms, theoretically, are the most abundant. No great numbers were found during the two seasons in which the most intensive work was done. During these two seasons the average depth of those found was 7.7 inches in 1922–1923 and 10.1 inches in 1925–1926.

A feature of especial interest brought out by this study is that wireworms were frequently found above a depth of six inches even in mid-winter where they encountered much colder conditions than those deeper in the soil, some of which went down as far as 36 inches. From this it is evident that the frequent recommendation for control of fall plowing to expose the wireworms to the rigors of winter may have less value than is usually attached to such a farm practice.

INTRODUCTION

During the course of a study on the depth of hibernation of white grubs and May-beetles, the results of which are now in press, the writers had opportunity to make some studies on the depth of hibernation of wireworms. Since there are in the literature, few, if any, recorded observations on the hibernation of the larvae of Elaterid beetles it seems worth while to note the present results. The paucity of observations on the winter habits of soil-inhabiting insects is due, in part, at least, to the difficulty of studying the habits of insects which live within the soil. A still more important factor in the case of wireworms is the difficulty of making specific identification of the larvae which, on the whole, must be reared to the adult condition before satisfactory de-

[1]Contribution No. 357. Kansas Agricultural Experiment Station. This paper embodies some of the results obtained in the prosecution of project No. 100 of the Kansas Agricultural Experiment Station.

terminations can be made. It has been the writers' experience that a period of five or six years may elapse between the time of collection of some species and the date of maturity. Naturally, many specimens are collected which cannot be reared to the adult. Because of these difficulties the observations herein noted apply to wireworms as a class. However, it is well to note that, in the vicinity of Manhattan, Kansas, where these studies were made, the majority of adult specimens collected belong to the genera *Melanotus*, *Monocrepidius*, *Lacon*, *Agriotes* and *Ludius*.

Methods

The present study was started during the winter of 1919–1920 and carried on at intervals when time was available. Emphasis was placed on the study of white grubs and for only three of the seasons between 1919 and 1926 were data collected on wireworm hibernation. All observations were made on soil removed inch by inch, by hand digging with a spade to depths varying from 14 to 48 inches. The size of the holes varied. During the winter of 1919–1920 five holes were dug, each of which was three feet square and only one wireworm was found during the season. No further wireworm observations were made until the fall and winter of 1922–1923 when a larger series of diggings was carried on. At this time 25 holes were sunk most of which were four feet square, a few however, were about six feet long, varying in depth from 14 to 48 inches. In each case digging was continued only as long as insects were being found. The intervening season, between 1922–1923 and 1925–1926 was unproductive as far as wireworms were concerned. During 1925–1926, however, the most extensive collections were made. At this time 38 holes were excavated each of which was two by three feet in area.

In each operation the soil was removed inch by inch and carefully sorted by hand for the insects. The number of wireworms found appears small, possibly because most of the digging was done in uncultivated areas on the higher uplands. However, the statement is common in the literature, that severe injury by these insects always follows the planting of crops on newly broken sod, which, if true, would lead one to look for the species in sod land, in order to find them in their natural state. Such locations probably afford more normal conditions than those of cultivated areas and one might expect in such places to find the greater number of individuals. Some observations, however, were made in lowland and sandy areas.

During the 1919-1920 season excavations were first made Oct. 24,

and none were made after cold weather had set in. The season of 1922–1923 studies were begun November 25 and were carried on throughout the winter until March 24. In 1925–1926 the first hole was dug November 20, and the last one March 20. The data secured during the two seasons, 1922–1923 and 1925–1926, in which the work covered the entire winter are probably more representative of average conditions.

Presentation of Data

During the fall of 1919–1920 only one wireworm was found in the five holes dug. This was taken in a hole dug around the base of a corn plant on Oct. 24. The depth at which it was found was between four and eight inches. Although this hole was sunk 20 inches, no other individuals were found. One of the other holes was in wheat stubble, another in bluegrass sod and the other two in ground overrun with bindweed.

The examinations of 1922–1923 were more productive. In all 18 wireworms were found in nine of the 25 holes dug. The greatest depth at which any individual was taken was 16 inches and the minimum depth was four inches with an average for the 18 of 7.7 inches. Most of these holes were in grassland; one was in a patch of sunflowers; one in an orchard; and another in grassland on a sand dune. It is of interest to note that the earlier diggings, Nov. 25, to Dec. 21, yielded specimens at depths varying from eight to sixteen inches, but on Dec. 21, an individual was taken at four inches or what is normally considered above the plow line (6 inches). On Dec. 23, another specimen was taken at six inches, and from that date on throughout the winter no individual was found below ten inches. In January and March specimens were taken at six inches, while in the sand dune area covered with dead grass one larva was found at five inches on March 23.

Wireworms were found in 25 of the 38 holes dug in 1925–1926. In each of two excavations ten individuals were taken; in the others generally only one but in a few cases two or three. Between Nov. 20, and Feb. 5, only one individual was found above the plow line while on Dec. 23, one larva was found at 6 inches. During this time the depths at which specimens were found ranged from eight to twenty-four inches with the majority between ten and fifteen inches. On Feb. 5, and frequently thereafter larvae were taken at shallow depths. However, on Feb. 27, one specimen was found in a sand dune area at 36 inches and on March 12 in river-bottom land one was collected at twenty-two inches. Two others were found on March 20 at 24 and 30 inches.

The collections of 1922–1923 and 1925–1926 are summarized and a comparison of the two seasons is shown in Table 1.

TABLE 1.—A SUMMARIZED COMPARISON OF THE 1922–1923 AND 1925–1926 HIBERNATION COLLECTIONS OF WIREWORMS

Date	Number collected	Depth collected		
		Minimum	Maximum	Average
1922–1923	18	4 inches	16 inches	7.7 inches
1925–1926	74	3 inches	36 inches	10.1 inches

SUMMARY

Since little information is available concerning the winter habits of wireworms, the foregoing data is offered as a preliminary report on studies made in Kansas. Most of the observations were carried on in prairie sod land where wireworms would normally be considered abundant. The diggings failed to reveal many larvae in such situations. Most of the observations were made during two seasons and the average depth of those found during the two winters was 7.7 inches in 1922–1923 and 10.1 inches in 1925–1926. The fact of greatest interest, however, is that wireworms were frequently found above a depth of six inches, even in mid-winter, a location where they would have to endure much greater cold than individuals which penetrated the soil to greater depths. It is evident that these insects can endure wide extremes of temperature and that the oft recommended practice of fall plowing to expose them to the rigors of winter may have less value than is commonly attributed to the practice. It is also of interest, that an average number of 10 wireworms for each two by three foot excavation, as was found in two instances in 1925–1926, would represent a total population of 72,310 wireworms per acre.

THE EFFECT OF SUBMERGENCE DURING THE HIBERNATING PERIOD ON PUPAL FORMATION AND ADULT EMERGENCE IN THE EUROPEAN CORN BORER

By MILTON F. CROWELL

ABSTRACT

The writer attempted to discover the effect of prolonged submergence of the hibernating larvae of the European Corn Borer, *Pyrausta nubilalis* Hubn., upon the subsequent life history of individuals surviving such submergence. Seventy-eight per cent of larvae immersed for eleven days died before pupation. Pupation and adult emergence in larvae that survived such a period of immersion was apparently normal. This is the record of but one experiment, and the results may not indicate what would happen in nature.

The effect of dessication during the dormant period of the European Corn Borer, *Pyrausta nubilalis* Hubn., has received considerable study. K. W. Babcock, ('27) states that if dessication occurs during the dormant period retardation of pupation results, and ('24) that a dry month of March produces the greatest delay. The purpose of the writer's experiment was to initiate a study of the effect of the opposite environmental condition, namely excessive moisture, during the dormant period. Unfortunately, circumstances prevented the carrying out of the work as planned, and only one experiment was carried to a point where results could be recorded.

In a former paper ('26) the writer discussed the effect of submergence in water on the hibernating larvae, and pointed out that the hibernating larvae of this insect can survive a period of submergence from six to seven times as long as can the active larvae. No data were secured, however, on the effect of prolonged submergence on the subsequent life of those individuals that survived it.

The larvae used in this experiment were of the two generation strain found in New England. They were obtained in the stalks in which they had entered hibernation from the European Corn Borer Laboratory of the Bureau of Entomology, U. S. Department of Agriculture, at Arlington, Mass.

On March 25, 1926, fifty larvae were cut from corn stalks and were submerged in water. They were kept in an outdoor screened cage, subject to natural temperatures. On April 5, after a period of eleven days the larvae were removed from the water. They were allowed to stand until April 10, in the cage, and on that date each larva was placed in a small glass tube, the ends of which were plugged with absorbent cotton, which was moistened from time to time.

On April 6 fifty larvae were cut from corn stalks of the same lot and each was placed in a short glass tube similar to the tubes used for the submerged larvae. These larvae were set aside as checks. All were kept in the screened cage together so that all would be subjected to the same environmental conditions.

Of the fifty larvae that were immersed there is one of which I have no further record. Of the check larvae, there are six upon which I have no further data, and one escaped.

Of the larvae that had been immersed in water for eleven days 39, or 78 per cent, died before pupation. Of the checks, 19, or 38 per cent, died before pupation.

Ten larvae that had been immersed pupated. Twenty-four of the check larvae pupated. The dates of pupation follow:

Date	Immersed	Check
June 14	1	
15–18		6
19	1	
21–23		3
24	1	1
25–28		6
29	4	
30		4
July 1	1	
2–9		4
10–14	2	

Seven adults were obtained from the immersed indivuduals, and seventeen from the checks.

The dates of adult emergence are as follows:

Date	Immersed material		Checks	
	Males	Females	Males	Females
July 5	1			1
6–9			5	
10	1	1		
11–16			4	3
18	2			
19			2	1
20	2		1	

By comparing these dates it appears that the date of maximum pupation was July 4 for both sets of pupae, when there were 8, or 80 per cent, of the pupae of the immersed larvae and 22, or 91.66 per cent of the pupae of the checks.

The appearance of the first adult was the same for both sets of pupae.

The date of maximum pupation was the same.

The appearance of the first pupa was in the immersed material, one day earlier than that in the checks.

The pupal period of the immersed individuals averaged 19.57 days, and that of the checks averaged 18.5 days.

Of the seven adults from the immersed material, 6, or 85.71 per cent, were males, and one, or 14.29 per cent was a female. In the checks, 12, or 70.59 per cent, were males, and 5, or 29.41 per cent, were females.

Although the percentage of surviving males was much greater in the immersed material than in the checks in this material it may well be that in this individual experiment such chanced to happen, and that further observations would not confirm this.

SUMMARY

1. The mortality of larvae submerged for a period of eleven days during the latter part of the hibernating period is apparently much greater than that of larvae not so treated.

2. Submergence of larvae in the latter part of the hibernating period apparently does not have much effect on the time of pupation of these larvae, or upon the time of emergence of adults from the pupae of larvae so treated.

3. In this experiment the pupal period of the individuals subjected to submergence was one day longer than that of larvae not so treated. These averages are not from equal numbers of pupae, so it would be unsafe to draw a conclusion regarding this point from these data.

4. A greater percentage of females emerged from pupae, the larvae of which had not been subjected to submergence, than emerged from larvae that had been submerged.

5. This is the record of a single experiment, hence the conclusions which might be drawn from it may well be erroneous.

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SUMMARY OF THREE YEARS' TESTS OF TRAP BAITS FOR CAPTURING THE CODLING MOTH

By M. A. YOTHERS, *Associate Entomologist, Bureau of Entomology, United States Department of Agriculture, Yakima, Wash.*

It has long been known that many kinds of insects are readily attracted to certain kinds of baits. Little, however, has been recorded of the value of any of these in attracting the codling moth (*Carpocapsa pomonella* L.). It was with the view of determining the actual value of various attractive baits in capturing the moths that preliminary tests were begun at the Yakima, Washington, Station.

Tests made after late July, 1923, with vinegar, synthetic apple oil, and fermented apple juice, placed in glass jars set in the crotches of apple trees, showed little promise for this method of supplementary codling moth control.

No tests of baits were made in 1924, but in 1925 more comprehensive experiments were made than in 1923, and in 1926 a large number of tests were conducted throughout the season.

METHOD OF USING TRAP BAITS. In 1925 the bait containers were hung on a nail well up in the tops of the trees. In 1926 they were suspended by a hop cord run through a screw-eye inserted in a horizontal limb in the topmost part of the trees.

The baits were replenished when they needed it—sometimes certain kinds of baits had to be replenished about every 6 days, but others could go longer. During cool weather all baits required less replenishment on account of retarded evaporation. In the 1926 season baits were operated from April 17 to September 23 (160 days), and moths captured over a period of 148 days.

KINDS OF BAITS AND THEIR COMPARISON. In 1925 (Table 1) tests against the spring brood with vinegar, diluted with water, 50, 25, 10, and 5 per cent, and fermented apple juice, showed the apple ferment over 13 times as effective as the poorest vinegar (50 per cent) and about 3½ times as effective as the best vinegar (5 per cent). In the first brood, when cider, vinegar (5 per cent), and fermented apple juice were compared, cider proved over six times as attractive as vinegar, and apple ferment over eight times as attractive.

TABLE 1.—RELATIVE VALUE OF CODLING-MOTH TRAP BAITS, SPRING AND FIRST BROODS, YAKIMA, WASH., 1925

Spring brood		First brood	
Bait	Average number of moths caught per jar-day	Bait	Average number of moths caught per jar-day
Vinegar, 50 per cent...	0.15	Vinegar, 5 per cent....	0.13
Vinegar, 25 per cent...	.21	Cider.....	.87
Vinegar, 10 per ent...	.58	Apple ferment.....	1.08
Vinegar, 5 per cent....	.59		
Apple ferment.....	1.99		

In 1926 a very large number of experiments were conducted with a considerable number of different kinds of materials, among which were molasses ferment, honey ferment, apple ferment (cooked and raw), vinegar, buttermilk, corn-wheat ferment (with and without apple oil), molasses and water, and about two dozen different kinds of essential oils. Tests were also made as to the most effective height at which to hang the baits in the trees; and several types of containers were compared.

In most of these tests, for which 15 experimental plats in the orchard were used, the three most effective trap baits were, in the order of their

effectiveness, molasses ferment, apple ferment, and honey ferment (Tables 2, 3, 4, 5, 6, 7). The general superiority of the molasses-ferment bait over all others tested seems apparent.

TABLE 2.—RELATIVE VALUE OF CERTAIN CODLING-MOTH TRAP BAITS, PLAT B, SPRING BROOD, YAKIMA, WASH., APRIL 26 TO MAY 14, 1926

Bait	Average number of moths caught per jar-day
Molasses ferment	2.31
Honey ferment	.93
Apple ferment	.80
Vinegar, 10 per cent	.47
Citronella oil	.39
Clove oil	.26
Sassafras oil	.24

TABLE 3.—RELATIVE VALUE OF CERTAIN CODLING-MOTH TRAP BAITS, PLAT H, SPRING BROOD, YAKIMA, WASH., MAY 23 TO JULY 4, 1926

Bait	Average number of moths caught per jar-day
Molasses ferment with dry yeast	1.04
Molasses ferment with fresh yeast	.93
Apple ferment	.33

TABLE 4.—RELATIVE VALUE OF CERTAIN CODLING-MOTH TRAP BAITS, PLAT G, SPRING BROOD, YAKIMA, WASH., MAY 17 TO 29, 1926

Bait	Average number of moths caught per jar-day
Molasses ferment	0.91
Apple ferment	.39
Honey ferment	.25
Vinegar, 10 per cent	.20

TABLE 5.—RELATIVE VALUE OF CERTAIN CODLING-MOTH TRAP BAITS, PLAT I, SPRING BROOD, YAKIMA, WASH., MAY 29 TO JULY 4, 1926

Bait	Average number of moths caught per jar-day
Molasses ferment	1.03
Corn-wheat ferment	.63
Corn-wheat ferment and apple oil	.50

TABLE 6.—RELATIVE VALUE OF CERTAIN CODLING-MOTH TRAP BAITS, COMPARABLE PARTS OF PLATS B, G, AND J, SPRING BROOD, YAKIMA, WASH., APRIL 29 TO JULY 4, 1926

Bait	Average number of moths caught per jar-day
Molasses ferment	1.04
Honey ferment	.57
Apple ferment	.44
Vinegar, 10 per cent	.16

TABLE 7.—RELATIVE VALUE OF CERTAIN CODLING-MOTH TRAP BAITS, PLAT A, FIRST BROOD, YAKIMA, WASH., JULY 10 TO SEPTEMBER 17, 1926

Bait	Containers	Average number of moths caught per jar-day
Molasses ferment	pans	3.28
Apple ferment, cooked	pans	2.76
Apple ferment, raw	pans	1.82
Apple ferment, cooked	jars	1.60
Apple ferment, cooked	pails	1.45
Molasses ferment	jars	1.45
Apple ferment, cooked, diluted 50/50	pans	1.27
Honey ferment	pans	1.09
Honey ferment	jars	1.06
Apple ferment, cooked, diluted 1 to 2	jars	.66
Apple ferment, raw	jars	.65
Apple ferment, cooked, diluted 50/50	pails	.60
Apple ferment, raw	pails	.54
Vinegar, 10 per cent	jars	.21

Of the essential oils tested only three, oil of cloves, oil of citronella, and oil of sassafras, showed any attractive value, and these captured few moths compared with the ferments (Table 2).

KINDS OF CONTAINERS. In the comparison of kinds of containers it was shown that 1½-gallon pails caught many more moths than "milk-kettles" or cuspidors (Table 8), but that enameled kettles or pans, 3 inches deep and 8 inches in diameter, were much more effective than the 1½-gallon pails or the quart fruit jars (Table 9).

TABLE 8.—RELATIVE VALUE OF VARIOUS KINDS OF CONTAINERS FOR CODLING-MOTH TRAP BAITS, PLAT D, SPRING BROOD, YAKIMA, WASH., APRIL 29 TO JULY 4, 1926

Containers with apple ferment	Average number of moths caught per jar-day
Pails, 1½-gallon, tin	1.01
"Milk-kettles," ½-gallon, tin	.62
Cuspidors, 1-quart, tin	.33

TABLE 9.—RELATIVE VALUE OF VARIOUS KINDS OF CONTAINERS FOR CODLING-MOTH TRAP BAITS, PLAT A, FIRST BROOD, YAKIMA, WASHINGTON, JULY 10 TO SEPTEMBER 17, 1926

Containers	Average Number of moths caught per jar-day in—			
	Molasses ferment	Apple ferment, cooked	Apple ferment, raw	Honey ferment
Pans or kettles, enameled	3.28	2.76	1.82	1.09
Jars, glass	1.45	1.60	.65	1.06
Pails, tin	—	1.45	.54	—

TABLE 10.—HEIGHT OF CODLING-MOTH TRAP BAITS IN TREES AS AFFECTING THEIR EFFICIENCY, PLAT B, FIRST BROOD, YAKIMA, WASH., JULY 22 TO SEPTEMBER 20, 1926

Bait	Position	Average number of moths caught per jar-day
Apple ferment	High	2.79
Apple ferment	Low	.65

HEIGHT OF BAITS IN TREES. In the comparison of height of baits in the trees (Table 10), it was found that baits hung well up in the tops of trees caught 4.29 times as many moths as did a like number of jars hung only about 5 feet from the ground.

PROPORTION OF SEXES. The proportion of the sexes, as shown in Table 11 for the three years during which these tests were conducted, indicates that somewhat more than half of the moths caught are females. Apparently about 55 to 60 per cent of the moths captured are females.

TABLE 11.—RELATIVE PROPORTION OF SEXES OF CODLING MOTHS CAPTURED IN BAITED TRAPS, YAKIMA, WASH., 1926

Year	Number of—		Per cent females
	Females	Males	
1923	93	68	57.76
1925	1,910	1,217	61.08
1926	8,575	6,585	56.56
Total	10,578	7,870	
Average			57.34

FEMALE MOTHS CAPTURED BEFORE DEPOSITING EGGS. A number of examinations of female moths during the season of 1926 showed about 95 per cent of them gravid or largely so. A very small number contained only a few eggs, and rarely one contained none. These semigravid or spent females had evidently not found the baits until after they had deposited their eggs, or those with no eggs may have been sterile. In other words it would seem that nearly all of the moths are captured in the baits soon after emergence and before they lay many of their eggs.

EFFECT OF TEMPERATURE UPON CAPTURE OF MOTHS. There is a very definite relation between temperature and the flight activity of the codling moth. This relation has been pointed out by other workers in connection with the deposition of eggs, but it is equally apparent in relation to the flight activity of the moths as indicated by the number captured in the baits. A few moths were captured even when it was running generally cool (around a mean daily temperature of 55 to 60°F.), but most of them are attracted when the mean daily temperature

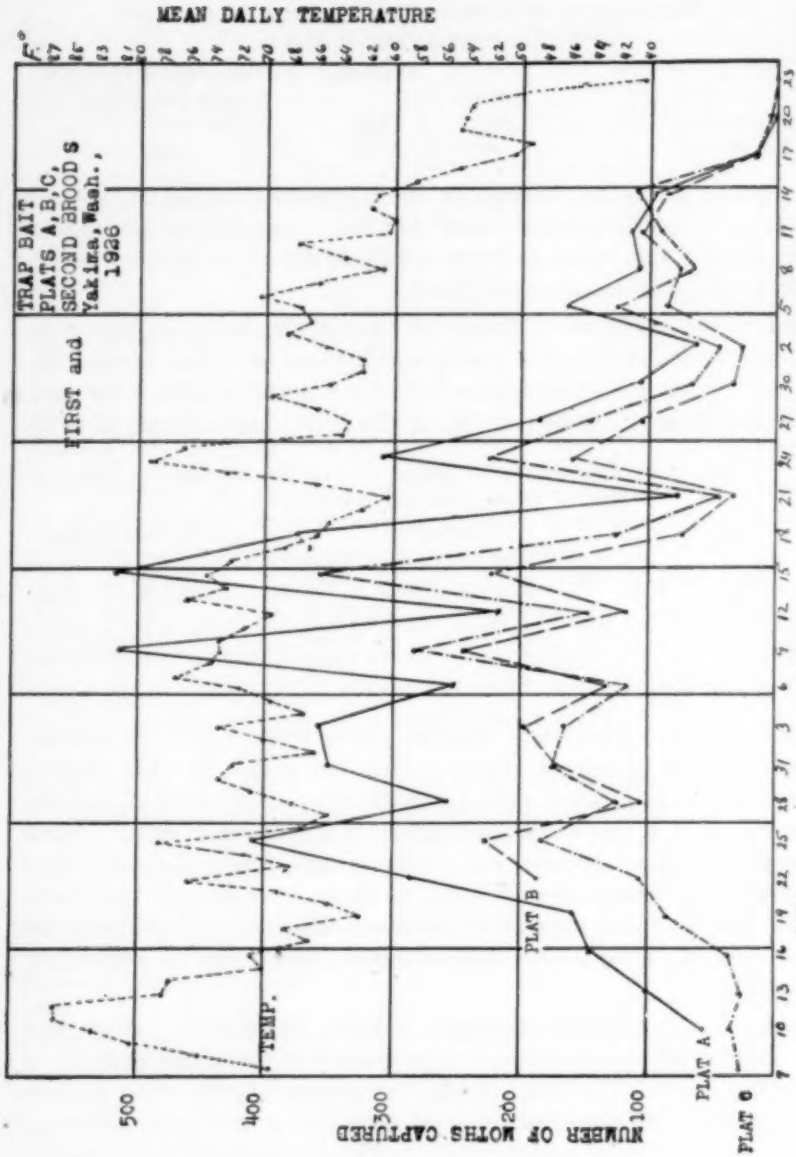

FIG. 19.—The effect of temperature upon the flight activity of the codling moth as indicated by the number of moths captured in trap baits in three experimental plats during the first and second broods, Yakima, Wash., 1926.

is above 70°F. A sudden drop in temperature will practically stop all moths from visiting the trap baits until it has warmed up again. In Figure 19 is shown graphically the regular rise and fall in the number of moths captured in three different plats during the flight of the first brood, as related to the temperatures of the three days immediately preceding each examination. The mean temperature for each day is given.

CONTROL VALUE OF TRAP BAITS. Although it has long been known that certain kinds of baits would attract the moths, it has never been definitely recorded, as far as we have been able to learn, just what is gained in actual control. The question naturally arose, Does capture of a few thousand moths materially affect the total number present in an orchard? In order to gain some information on this point a thorough test was made the past season as follows: A block of 42 apple trees was baited with apple ferment, a quart fruit jar to each tree, from April 20 to September 23. At harvest time the crop on 12 trees in this block and 12 trees outside this block was counted and examined for the percentage of fruit free from worms and stings. In the baited block 6 Jonathan trees averaged 92.06 per cent free from all worms and stings (Table 12); a like number of Jonathans in the unbaited block averaged 79.93 per cent free from worms and stings. Six Rome Beauty trees in the baited block averaged 90.36 per cent fruit free from worms and stings, and a like number of the same variety in the unbaited block averaged 74.77 per cent of the fruit free from worms and stings. In other words, the baits in the Jonathans showed an increase of clean fruit of 12.13 per cent, and the Rome Beauties an increase of 15.59 per cent. Both blocks had received the same spraying by the owner. Certainly a control measure that increases the proportion of clean fruit 16 per cent (from 74 to 90 per cent) or 12 per cent (from 80 to 92 per cent) is worthy of consideration as at least promising provided such a measure is within the bounds of reasonable expense.

TABLE 12.—CONTROL VALUE AGAINST THE CODLING MOTH OF APPLE FERMENT BAIT IN A BLOCK OF 42 TREES, WITH BAIT JARS IN EACH TREE FROM APRIL 20 TO SEPTEMBER 23, YAKIMA, WASHINGTON, 1926

Plat	Variety	Treatment	Per cent of fruit free from worms and stings	Per cent of increased control
I	Jonathan	Baited	92.06	12.13
II	Jonathan	Unbaited	79.93	——
I	Rome Beauty	Baited	90.36	15.59
II	Rome Beauty	Unbaited	74.77	——

COST OF TRAP BAITS. The figures on the cost of operating trap baits are largely a matter of estimate and theoretical computation. However, after very careful consideration, the following estimates have been made. Estimates for the molasses ferment and the apple ferment only are given as all other baits tested seem to fall far behind these in value, except the honey ferment, which is too expensive to be seriously considered. The estimated cost is given per tree per season of 20 weeks from late April to late September.

Molasses ferment bait	Cost per tree per season
Molasses	$0.1500
Yeast	0.0125
Screw-eye	0.0050
String	0.0200
Pan	0.1500
Labor	0.2400
Total	$0.5775 (or 58 cents)

This expense could very probably be greatly reduced as follows: (1) By purchasing cheap molasses in large quantities, provided that this should prove as attractive as the better grades; (2) by diluting the molasses 1 to 20 instead of 1 to 10 as at present, provided this should prove as effective; (3) by hiring cheap labor (boys could do this kind of work as well as higher priced labor); (4) by eliminating two or more of the late September examinations, when few moths would be captured at best; (5) by using the pans for three or more years instead of one, thus reducing the cost of containers by cutting it into thirds. With all of these reductions the annual cost per tree would probably not greatly exceed one-half the estimated amount.

The cost of the apple-ferment bait is about the same as the cost of the molasses ferment except in the matter of the apple juice alone, which is mainly the cost of labor in grinding and cooking the apples. It is estimated that this could be done in large quantities for about 1 cent per tree per season, but for smaller lots, for 5 acres or less, the cost would probably run around 4 to 5 cents. In other words, the apple ferment bait, while apparently not so efficient as the molasses ferment, would probably cost about 45 to 50 cents per tree per season compared with 55 to 58 cents for the molasses ferment.

SUMMARY AND CONCLUSIONS

In badly infested apple orchards thousands of codling moths to an acre can be captured in properly baited traps during the moth season.

Cooked, fermented apple juice, containing some of the apple pulp,

proved more attractive in capturing the moths than vinegar or cider.

In 1926 a molasses ferment proved much more effective than apple ferment, honey ferment, or any of some two dozen essential oils.

Of the essential oils only three, oil of cloves, oil of citronella, and oil of sassafras, proved attractive to the codling moths.

The most promising type of bait container so far found is an enameled kettle about 8 inches in diameter and 3 inches deep.

Several times as many moths can be captured in baits in the tops of trees as in baits at the height of the crotches.

About 55 or 60 per cent of the moths captured are females.

Of the moths caught about 95 per cent are gravid, having laid none or very few of their eggs before capture.

Trap baits show the beginning and end of the codling moth season, the beginning and end of each brood, and the maximum abundance for each, and this information may be used to advantage in arranging spray dates for moth control.

Codling moths are not attracted to baits during cool weather. Most of them are captured while the mean temperature is 70°F. or above.

In a baited test block of 42 trees, final counts of fruit at harvest time showed an increase of from 12 to 16 per cent over similar varieties similarly sprayed but unbaited.

The cost of molasses ferment, which proved the most efficient, is estimated at not over 58 cents per tree per season, and for the apple ferment about 45 to 50 cents on the same basis.

Apparently there is a possibility that some attractive bait may be discovered which will attract and capture the codling moth in such numbers that it may be recommended as a satisfactory supplementary control measure.

CALCIUM CYANIDE FOR THE CONTROL OF THE SQUASH BUG, *ANASA TRISTIS* DE GEER

By V. A. LITTLE, *College Station, Texas*

ABSTRACT

During the summer of 1926 experiments were conducted upon squashes with cyanogas calcium cyanide "A" dust for the control of squash bugs. Over 80% control was obtained with undiluted dust. All dusting was done in the open air. Applications were very heavy, using 1½ ounces of dust per hill. Little or no injury was noted when the dust was properly applied.

An effort was first made to control squash bugs with nicotine dust. Dusts containing 2% and 4% nicotine were used; both proved inefficient.

Cyanogas calcium cyanide "A" dust was next employed. In addition to the experiments with the undiluted "A" dust other experiments were conducted with a dust made by mixing it with various proportions of air slaked lime in an effort to obtain a cheaper product and one with better dusting qualities. Preliminary experiments showed that the undiluted dust and a mixture of one part "A" dust with one-half part air slaked lime were worthy of further trial. All dusting was done in the open air; the dust was delivered with a hand duster. The applications were thoroughly made; about 1½ ounces was used upon each hill.

All tests were made upon plats containing from seven to twelve hills each. Counts were made from one hill in each plat. The stupefied bugs from each hill upon which counts were made were spread upon the ground in wire cages, 1′ x 1′ x 2′ in the field. Checks were run by placing an equivalent number of nymphs and adults in similar cages under the same conditions and kept there until all the stupefied bugs from the dusted plats had either died or recovered. Fresh leaves with stems attached were placed in the cages twice daily. Table 1 shows the results obtained.

TABLE 1

Plat No.		Nymphs		Adults		Total
		Total	% Died	Total	% Died	% Died
1	Calcium cyanide undiluted	307	89.2	7	42.9	88.2
2	Calcium cyanide and lime	1138	83.9	2	50.0	83.8
Check 1 and 2		304	8.2	18	0	7.8
3	Calcium cyanide undiluted	262	84.7	22	77.3	84.2
4	Calcium cyanide and lime	103	55.3	12	25.0	52.2
Check 3 and 4		200	0.5	9	0	0.5

Upon examination of this table it is seen that fair control was obtained with the straight "A" dust. The reason for the high mortality in the check for plats 1 and 2 seems to be that at this time the major per cent of the nymphs were newly hatched. A comparison of the total number in 3 and 4 shows a material decrease in the latter.

When the plats were dusted the bugs were quickly stupefied; the time varying from twenty seconds to one minute, depending upon the dosage and the wind velocity. All that were stupefied were by no means dead. A few recovered within a few minutes. All adults that did recover did so within twenty-four hours. Some showed signs of life after forty-eight hours but none recovered. Very few nymphs recovered after twenty-four hours and none after forty-eight hours, however, a few still showed

signs of life after seventy-two hours. Table 2 shows the per cent of bugs that recovered.

TABLE 2

Plat No.	Nymphs		Adults		Total
	No. Stupefied	% Recovered	No. Stupefied	% Recovered	% Recovered
1	304	9.9	7	57.1	10.9
2	1084	11.8	2	50.0	11.9
3	262	15.3	22	22.7	15.8
4	101	5.5	12	75.0	48.7

Checks as for Table No. 1.

Burning resulted only when the dust was applied very heavily directly upon the leaves. Ordinarily there is no need of applying the dust directly upon the leaves as the bugs are found upon the stems near the base of the plants. The insects are found in numbers on the leaves only when the nymphs are small; in this case they are brushed to the ground and then dusted, thus eliminating the possible danger of burning and getting them where the dust will be more effective. Table 3 shows the weather conditions at the time of dusting.

TABLE 3

Plat No.	Date	Time	Estimated wind velocity	Temperature	Humidity
1	July 17	3:00 P. M.	4 Mi.	88	58
2	July 17	4:30 P. M.	5 Mi.	87	55
3	July 23	9:30 A. M.	3–4 Mi.	80	92
4	July 23	10:00 A. M.	3–4 Mi.	80	88

LEAF-HOPPERS INJURIOUS TO APPLE TREES IN THE HUDSON VALLEY

By F. H. LATHROP[1]

ABSTRACT

A leaf-hopper (*Typhlocyba pomaria* McAtee) closely resembling the rose leaf-hopper (*T. rosae* Linn.) was observed causing serious injury to apple trees in the Hudson Valley. The injury takes the form of white stippling of the foliage, resulting in serious loss of chlorophyl in severe cases. More or less discoloration of the fruit results from the honey dew discharged by the insects. Severe infestation was observed on McIntosh, Baldwin, and Greening apple trees, ranging from McIntosh of early bearing age to mature Baldwins.

The adults of *T. pomaria* and *T. rosae* are distinguished by the structure of the genitalia; the nymphs of the former species lack the dark spots characteristic of *T. rosae*.

[1]The writer is indebted to Professor P. J. Parrott for encouragement in carrying on this work, and to Mr. W. L. McAtee for assistance in examinations of the male genitalia of the species involved.

The winter eggs of *T. pomaria* are found in apple bark, mostly on second year wood. In 1924 hatching began on May 19, two weeks later than the hatching of the first eggs of *T. rosae*. The first adults appeared during the third week in June. The first eggs of the second generation were observed on July 23. Hatching began during the second week in August, and adults appeared in mid-September. The winter eggs are deposited during late fall.

The most effective control of *T. pomaria* was secured by an application of nicotine sulphate (¾ pint to 100 gallons), applied after all of the winter eggs had hatched but before any adults appeared. Two per cent nicotine-lime dust was effective during mid-July when the adult hoppers predominated. Oil sprays, applied at the delayed dormant period, proved ineffective in destroying the winter eggs.

During the seasons of 1923 and 1924, while employed by the New York Agricultural Experiment Station, the writer had opportunity to make observations on leaf-hoppers infesting apple orchards in the fruit sections of the Hudson Valley. A number of orchards were observed, in which the owners reported that severe leaf-hopper infestation had persisted for several years.

At first it was believed that this was the rose leaf-hopper, *Typhlocyba rosae*. As the work progressed, it soon became evident that there were two species involved: the rose leaf-hopper, *Typhlocyba rosae* Linn., occurring on apple during the summer months, and wintering on rose; and another species, which spends its entire life cycle upon apple. The latter species has been described by McAtee in his recent monograph on the genus Typhlocyba, in which he gives it the name *Typhlocyba pomaria*.[2]

Distinguishing Characteristics. The eggs of *T. pomaria* so closely resemble those of the rose leaf-hopper, that no means was found for distinguishing them. The winter eggs of the rose leaf-hopper were observed to be placed under the bark, usually parallel to the axis of the stem, while the eggs of *T. pomaria* are characteristically placed at right angles to the axis of the stem. The writer cannot say that this is invariably the case, however.

The Nymph of *T. pomaria* may be distinguished by the absence of the dark spots at the bases of the thoracic bristles, which are characteristic of the rose leaf-hopper.

The Adult very closely resembles the rose leaf-hopper in color and in general shape and size The males of the two species may be distinguished by the structure of the aedeagus. The ultimate ventral segment of the female is distinctive, but in many cases this becomes

[2]McAtee, W. L., *in* Proc. U. S. Nat'l. Museum, Vol. 68, Art. 18, pp. 1–47, pls. 1–6, 1926.

distorted in dried, mounted specimens. There are also differences in the wing venation, that seem quite constant.

Economic Importance. In a number of apple orchards in the Hudson Valley, severe injury has been noticed, and the writer has observed one orchard where the infestation has persisted for at least four years. The injury produced is apparently identical with that caused by the rose leaf-hopper. The leaves show white stippling on the upper surface along the veins as the nymphs begin to feed. As infestation becomes more severe, the white spots become more abundant, until the whole leaf becomes pale in color, and in extreme cases the tree may lose a large proportion of its chlorophyl. In addition to this foliage injury, there is more or less trouble from the discoloration of fruit by excreta, which is quite characteristic of leaf-hopper attacks. Some fruit growers believe that severe attacks of this leaf-hopper resulted in a reduction in the size of the fruit, and in failure of the fruit to color properly.

Severe infestations were observed on McIntosh, Baldwins, and Greenings, and there are probably other varieties that suffer equal

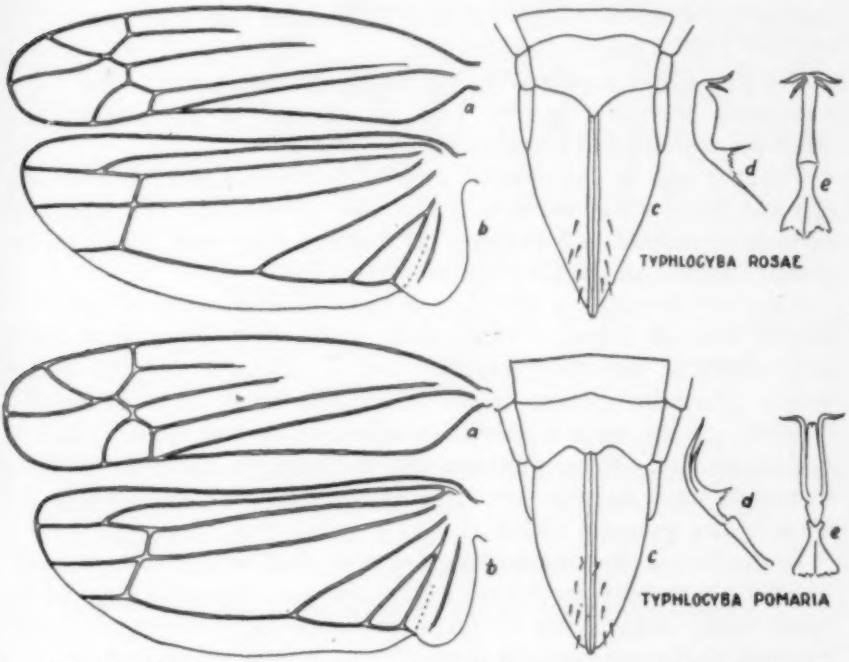

Fig. 20.—*Typhlocyba rosae* and *T. pomaria: a.* Elytron. *b.* Wing. *c.* Female ultimate ventral segments. *d.* Aedeagus, lateral view. *e.* Aedeagus, dorsal view.

injury. The trees affected ranged in age from McIntosh of early bearing age to mature Baldwins. No infestation was observed on very young trees.

DISTRIBUTION. Infested orchards were observed at Marlborough, Milton, Clintondale, and Highland, New York. In all of these orchards *T. pomaria* far outnumbered *T. rosae*. In no case was a severe infestation of *T. rosae* observed in an apple orchard in the Hudson Valley; no thorough survey was made, however. An examination of the experiment station orchards at Geneva, N. Y., in 1924 showed infestation by *T. rosae*, but no specimens of *T. pomaria* were found.

In view of the fact that McAtee reports *T. pomaria* widely distributed throughout the United States and Canada, it seems likely that severe infestations of this species occur in apple orchards here and there as local environmental factors and climatic conditions favor the development of the species. This spotted nature of infestation seems characteristic of a number of leaf-hopper species.

LIFE HISTORY. The overwintering eggs of *T. pomaria* are deposited in apple bark, mostly on second year growth. In 1924 the first eggs hatched on May 19, which was two weeks later than the hatching of the first eggs of the rose leaf-hopper.

The first adults appeared during the third week in June. The metamorphosis proceeded rapidly, and, by the end of June, practically all of the nymphs had transformed into adults.

The first eggs of this generation were observed on July 23, when one egg was found imbedded in a leaf petiole. Three days later eggs had become numerous, and as many as fourteen eggs were found in the petiole, midrib, and larger veins of a single leaf.

The first nymphs of the second generation appeared during the second week in August. Infestation rapidly grew more severe, and with adults of the first generation and all stages of nymphs of the second generation present on the foliage, the injury became excessive.

Adults of the second generation appeared on the apple foliage in mid-September. From this time on, the relative numbers of adults increased, until mid-October, when most of the hoppers were in the adult or late nymphal stages.

During late afternoons in November or on dull, cloudy days, numbers of adults may be observed depositing the over-wintering eggs in the apple bark. Adults may be found in decreasing numbers until frost removes the foliage from the trees.

CONTROL. The most effective control of *T. pomaria* in apple orchards

of the Hudson Valley was secured by a well timed application of nicotine sulphate (¾ pint to 100 gallons), applied so as to kill the nymphs. This application should be made during late May or early June after all of the overwintering eggs have hatched, but before any of the adults have appeared. The nicotine sulphate may be added to one of the customary applications scheduled to be made during this period, thereby eliminating the necessity for an additional spray application. It is advantageous to make the application promptly after all of the eggs have hatched, for the early stages of the nymphs are more susceptible to the spray than are the nearly mature nymphs.

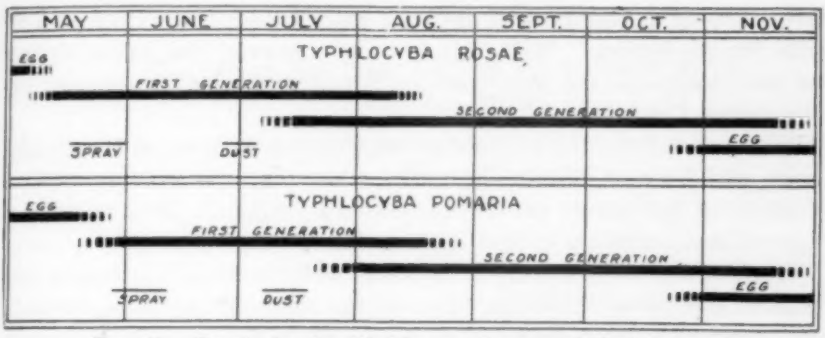

FIG. 21.—Graph showing life history of two apple leaf hoppers.

There is a period during mid-July when practically all of the first generation hoppers have transformed to adults, yet few, if any, eggs have been deposited. This period is most advantageous for dust applications. Experimental applications of 2 per cent nicotine-lime dust proved effective against the adults when weather conditions were satisfactory.

Oil sprays, applied at the delayed dormant period, in an effort to destroy the overwintering eggs, proved ineffective, and resulted in no material reduction of leaf-hopper infestation.

NOTES ON COLLECTIONS OF THE SUGAR BEET LEAF-HOPPER SHOWING THE EXTENSION OF ITS KNOWN RANGE INTO BRITISH COLUMBIA AND TO THE COAST IN WASHINGTON AND OREGON

By EDGAR W. DAVIS, *Junior Entomologist, Bureau of Entomology*

ABSTRACT

The known range and breeding areas of the sugar beet leaf-hopper (*Eutettix tenella* Baker) are important in locating new areas for the production of sugar beets.

The results of the survey recorded in this paper extend the known range of the leafhopper to the coast in Washington and Oregon and into British Columbia, 140 miles north of the international boundary. Observations on the stage of the insect, host plant, date and locality are recorded.

Introduction

Information regarding the known range of the sugar beet leaf-hopper (*Eutettix tenella* Baker) and the locations of breeding areas is of importance when new areas for sugar beet production are under consideration. Such information increases in importance when severe losses occasioned by repeated leaf-hopper outbreaks in the areas now devoted to sugar beet growing lead the sugar beet industry to seek new fields for production. With this in view, a survey was made during the past season on the west coast of Washington and Oregon and up into British Columbia.

Ball[1] reported that *E. tenella* was swarming on Atriplex at Pendleton, Oreg., and Yakima, Wash., in 1909. Also, that this leaf-hopper was common as far north as Wenatchee, Washington. In 1904 Titus[1] reported serious injury in beet fields at Echo, Oreg.

Carter[2] notes the presence of the insect as far west as The Dalles and south in Oregon to Prineville; also, as far north as Okanogan, Wash.

The records of collections of *E. tenella* made during 1926 in British Columbia and on the west coast of Washington and Oregon follow.

Wenatchee Valley, August 10

This part of the survey duplicates the work done last year[2] and confirms the data then obtained. Adults and nymphs of *E. tenella* were found throughout the valley. The host plants were Russian thistle (*Salsola pestifer* A. Nels.) and Jim Hill mustard (*Norta altissima*(L.) Britton). The latter was dead and the leaf-hopper was not collected from it.

Okanogan Valley, August 12

This valley extends from Okanogan, Wash., to Chase, B. C. The south end of the valley, the widest part, was covered with grass and sage brush. Toward the north the valley narrows until it is lost in the forest-covered hills. Adults and nymphs of *E. tenella* were collected from Russian thistle and mangels. Other host plants found in this valley were Jim Hill mustard, *Atriplex rosea* L., and filaree (*Erodium cicutarium* (L.) L'Her).

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[1]E. D. Ball, Utah Agric. Col. Exp. Sta. Bul. 155.

[2]Walter Carter, Manuscript notes.

Thompson Valley, August 14

The Thompson valley was entered at Chase, B. C., and followed through Kamloops and Ashcroft to Spencer's Bridge, B. C. This valley was narrow and winding. At Chase the forest extended to the edge of the valley, while farther down the lower hills were covered with grass and sage brush. Both adults and nymphs were collected from Russian thistle at Chase and Merritt. Near Ashcroft the leaf-hopper became very scarce and only adults were collected. The mustard was greener in this valley than any which had been noted earlier in this survey, but no *E. tenella* could be found on it. *Atriplex rosea* and *Erodium cicutarium* were also found in this valley.

Valley of Bonaparte River From Ashcroft to Canim Lake, August 17

From Ashcroft the survey turned north and followed the Bonaparte River to Clinton. *E. tenella* was found only at Cache Creek which is 8 miles north of Ashcroft. Mangels, *Atriplex rosea*, *Erodium cicutarium*, and Russian thistle were present in this area.

From Clinton to Canim Lake the valleys lie at right angles to the road. All the hills were covered with forests, consequently collections were made only in the valleys. No sugar beet leaf-hoppers were collected in this area, although the following host plants were found: *Atriplex rosea*, *Erodium cicutarium*, mangles, and Swiss chard (*Beta vulgaris*).

At Cache Creek, B. C., the northern limit at which *E. tenella* was found, only adults were taken. These might have migrated from the south. At Merritt the leaf-hopper was breeding, as both adults and nymphs were found. *Erodium cicutarium*, which is an early spring plant, grows rank during the summer in this area and remains green until late fall. Other summer host plants have been noted. This section could be a natural breeding area, as far as host plants are concerned.

Western Washington, August 30

From the Canadian border to Olympia, Wash., the farming region lies but little above sea level. This district is divided naturally into small farming areas by low forest-covered hills. The host plants of the leaf-hopper in this region were beets, mangels, *N. altissima*, *E. cicutarium*, and *A. rosea*. At Bellingham, Mt. Vernon, and Kent the leaf-hopper was found on beets. The other host plants were uninfested.

From Olympia to Vancouver, Wash., the course of the survey was between the Cascade Mountains and the Coast Range. The general

FIG. 22.—Area in the Pacific Northwest covered by the sugar beet leaf-hopper survey made in 1926.

elevation of the farming area here was higher than that previously described. This region is divided into small valleys enclosed by forest-covered mountains. In addition to the host plants previously mentioned, the following were found: *Sanguisorba annua* Nutt. and *Anthemis cotula* L. At Centralia and Toledo the leaf-hopper was found on mangels.

Western Oregon, September 7–15, 1926

The major part of the survey in western Oregon was made between the Cascade Mountains and the Coast Range, from Portland to Grant's Pass. This region is divided into valleys of various sizes, each surrounded by forest-covered mountains. The type of farming varies from grain to truck farming and dairying. Mangels were plentiful throughout this region. Other host plants found there were beets, *Erodium cicutarium*, *Atriplex rosea*, and *Sanguisorba annua*. The only place that *E. tenella* was found was at Newberg, on mangels.

The minor part of the survey was made along the coast between Tillamook and Newport, and in the region between Marshfield and Bandon. Dairying was the main type of farming; consequently, mangels were plentiful. At Cloverdale adults and nymphs were collected from mangels. Other host plants found on this part of the survey were *Atriplex rosea* and *Erodium cicutarium*. The latter plant grows in this section the entire year. Summer plants appear early in the spring and remain late in the fall. These conditions indicate that this section could be a natural breeding area.

Summary

Nymphs and adults of the sugar beet leaf-hopper (*Eutettix tenella* Baker) were found throughout the Wenatchee and Okanogan Valleys and as far north as Merritt, B. C.

The northern limit at which the insect was found was Cache Creek, B. C.

Adults were found west of the Cascade Mountains in Washington and Oregon, and both adults and nymphs were found west of the Coast Range at Cloverdale, Oreg.

Throughout this entire survey, where the insect was found on beets or mangels, the curly-top disease was present.

This survey extends the known range of the sugar beet leaf-hopper to the coast in Washington and Oregon, and into British Columbia 140 miles north of the international boundary.

The accompanying table and map show the location and host plants of collections made during this survey.

COLLECTIONS OF THE SUGAR BEET LEAF-HOPPER MADE IN A SURVEY IN OREGON, WASHINGTON, AND BRITISH COLUMBIA IN 1926

Area	Locality	Host	Stage collected
Wenatchee Valley	Wenatchee, Wash.	Russian thistle	Adults and nymphs
	Chelan, Wash.	do	Adults
	Pateros, Wash.	do	Adults and nymphs
	Okanogan, Wash.	do	do
Okanogan Valley	Oroville, Wash.	do	Adults
	Osoyoos, B. C.	do	Adults and nymphs
	Summerland, B. C.	Mangels	do
	Kelowna, B. C.	do	Adults
	Vernon, B. C.	Russian thistle	do
	Armstrong, B. C.	Mangels	do
	Salmon Arm, B. C.	do	do
Thomson Valley	Chase, B. C.	Russian thistle	Adults and nymphs
	Kamloops, B. C.	do	Adults
	Ashcroft, B. C.	do	do
	Merritt, B. C.	do	Adults and nymphs
Valley of Bonaparte River	Cache Creek, B. C.	do	Adults
Western Washington	Bellingham	Beets	Adults
	Mt. Vernon	do	do
	Kent	do	do
	Centralia	Mangels	do
	Toledo	do	do
Western Oregon	Newberg	do	do
	Cloverdale	do	Adults and nymphs
	The Dalles	Russian thistle	do

CURLY-TOP OF SUGAR BEETS IN SOUTH DAKOTA

By HENRY H. P. SEVERIN, Ph.D., *California Agricultural Experiment Station*
and HARRY C. SEVERIN, M.A., *South Dakota State College*

ABSTRACT

Curly-top of sugar beets was found to occur, on rare occasions, in the beet fields of the west central part of South Dakota. Sweepings with an insect-net from the most favorable host plants of the beet leafhopper (*Eutettix tenella* Baker) failed to include a single beet leafhopper. It was demonstrated, however, that non-infective beet leafhoppers transmitted curly-top from South Dakota diseased beets to healthy beet seedlings under greenhouse conditions in California.

Curly-top of sugar beets was found in the beet fields in the territory of the Great Western Sugar Company in the west central part of South Dakota during the summer of 1926. An examination of one of the beet fields of the Great Western Sugar Company Farm, situated about one mile east of Belle Fourche, showed the presence of three curly-top beets in about 100 feet of beet row. A general survey was then made

of 3000 acres of beets in South Dakota and in many fields not a single diseased beet could be found. A typical case of curly-top in an advance stage of the disease with wart-like protuberances on the lower surface of the leaves was found on the Federal Experiment Farm near Belle Fourche. A badly stunted diseased beet was removed from a field near a beet dump at Nisland. After the general survey was made, it was decided to spend another day in the beet fields of the Great Western Sugar Company Farm totaling about 1100 acres. A general survey of the beet farm showed that curly-top was scarce, for not more than one diseased beet could be found in a half hour's search.

Beets showing the early symptoms of curly-top, namely the transparent veinlets on the inner or youngest leaves, or the advanced stage of the disease already described were sent from South Dakota to the greenhouse at the University of California. Non-infective beet leafhoppers transmitted curly-top from six of these beets to healthy beet seedlings. Repeated tests of non-infective beet leafhoppers failed to transmit the disease from one beet with a white venation and outward curled and crinkled leaves to healthy beets.

In our survey, a cross section of the northern and central parts of South Dakota was made, and in this survey over 1500 miles were covered in an automobile from August 9 to 18, 1926. The most favorable host plants of the beet leafhopper were swept with an insect-net but not a single specimen of *Eutettix tenella* Baker was captured. Russian thistle (*Salsola kali tenuifolia*), one of the most favorable introduced host plants of the leafhopper was most abundant in South Dakota. Another favorable introduced host plant was Red Orache (*Atriplex rosea*). Among the favorable native annual saltbushes was Fog Weed (*A. argentea*), Spear Orache (*A. patula hastata*) and Ribscale (*A. powelli*). Moundscale (*A. nuttalli*) a perennial saltbush, occurred in the northwestern part of the State. Several species of Pigweeds (*Chenopodia*) were also swept with an insect-net. Tumbling Mustard (*Sisymbrium altissimum*), one of the most important host plants of the beet leafhopper in Idaho, on the authority of Mr. Walter Carter, was also found in northwestern South Dakota.

Much of the Black Hills are forested, while the foothills are covered in part with tall grass, conditions which do not produce favorable natural breeding areas of the beet leafhopper.

No beet leafhoppers were taken on favorable host plants in the south central and southeastern parts of the State by the junior writer in a second trip covering 800 miles from September 1 to September 12, 1926.

No beet leafhoppers were found among the undertermined Jassids

collected in South Dakota during the past two years by the junior author, nor in the large collection of determined Jassids collected by the same individual during the past 15 years.

West central and northwestern South Dakota may be the eastern limit of a natural breeding ground of *Eutettix tenella*, providing the few cases of curly-top which we found were caused by this insect. Semi-arid conditions, some alkali soil with an occasional alkali sink covered with favorable host plants of the beet leafhopper were found in this locality. In the extreme northwestern part of the State, the average rainfall is less than 15 inches, in the Belle Fourche district 14 inches, an amount which at least some of the leafhoppers survive in the natural breeding areas of California. If *Eutettix tenella* is responsible for the diseased beets which we found in South Dakota, there is a possibility that the insect migrated into west central South Dakota from more remote breeding sections. Investigations should be conducted over a period of several years to determine whether west central and northwestern South Dakota is the boundary of a natural breeding area and whether or not a dispersal of leafhoppers takes place from this section or whether a migration in South Dakota takes place from regions outside of the State.

ACKNOWLEDGMENT

The survey of South Dakota for the beet leafhopper and curly-top of sugar beets was undertaken by the Bureau of Entomology, Truck Crop Investigations, Washington, D. C. and the writers are deeply indebted to Dr. L. O. Howard, Mr. J. E. Graf and Mr. Walter Carter. The salt bushes (*Atriplexes*) were kindly determined by Dr. H. M. Hall, Carnegie Institution of Washington.

THE DIPTEROUS PARASITES OF THE MIGRATORY LOCUST OF TROPICAL AMERICA, *SCHISTOCERCA PARANENSIS* BURMEISTER

By J. M. Aldrich, *U. S. National Museum*

In 1925 I had occasion to examine and identify a considerable collection of Diptera reared by Dr. Alfons Dampf from the above locust, which is a serious pest from Argentina to the latitude of Vera Cruz. In the spring of 1926, I spent two months in Guatemala, where my attention was called to some parasites by Mr. J. G. Salas, Director-General of Agriculture; I also made some observations in the field

among the locusts. After my return I had some correspondence which increased my information on the subject.

The following notes seem to be worth recording for the use of others, as the host is of great economic importance in the American tropics.

Oedematocera dampfi Aldrich

Oedematocera dampfi Aldrich, Proc. Ent. Soc. Wash., vol. 29, 1927, p. 17.—Greene, ibidem, p. 18, figs. larva and pupa.

In 1924 some very peculiar larvae were sent in by Professor Herrera, of Mexico City, which had been taken from specimens of the Migratory Locust; we asked especially to have specimens of the adult fly, and he sent the present species. In the following year Dr. Dampf sent in a considerable number of adults, with puparia, from the same host. In visiting Guatemala, I called upon Mr. J. G. Salas, Director-General of Agriculture, shortly after my arrival in the capital, and he showed me more of the same easily-recognized puparia, which had come from locusts in the country. I did not myself come in contact with this species of parasite in my short stay in the country, but after my return I received adult flies from Mr. Salas, and parasitized locusts from Mr. C. M. Rouillard, sugar grower at La Providencia, Siquinala, Guatemala (on the west slope below the volcano Fuego). Mr. Rouillard also informed me that at his place the locusts congregated in the trees at night in their usual manner, and in the morning he could collect "any quantity" of the white larvae of this parasite on the ground under the trees; in a few hours they had changed to the puparium. The locusts were not immediately killed, but flew away.

It is apparent from the wide distribution of this species in Mexico and Central America and its occasional large numbers that it may become a very important factor in controlling the migratory locust.

The locusts sent in fluid by Mr. Rouillard were fifteen in number, six being unparasitized, the other nine all containing from one to three larvae of *dampfi;* one specimen contained one *dampfi* and two of a Sarcophaga, presumably *caridei*. In spite of the highly specialized appearance of the stigmal plates in *dampfi* larvae, I found the maggots lying free in the abdominal cavity, always close under the posterior end of the alimentary canal; if several were present, they were as close as possible to that position. None of the parasitized female locusts that I cut open contained any eggs in recognizable form. I am unable to say from present knowledge how long a parasitized locust can live, nor whether a female can lay eggs if attacked. From what is known

of other parasites, it would seem a very remote possibility that eggs would develop in the abdomen occupied by one or more maggots. The reproductive habit is unknown beyond what is indicated.

Sarcophaga caridei Brethes

Sarcophaga caridei Brethes, Anales Mus. Nac. Buenos Aires, viii, 1906, 299, figs.; xxii, 1912, 441, syn.—Dawe, Revista Agricola, Bogota, ii, No. 3, 143–150, 1916.
Nemoraea acridiorum Weyenb., Conil, Bol. Acad. Nac. Cordoba, iii, 1881, 426, pl. v. and vi.—Lahille, Anales del Ministerio de Agricultura, Seccion de Zootechnia, etc., Tomo iii, 1907, No. 4, 38, 50, 67.
Sarcophaga angustifrons Aldrich, Sarcophaga and Allies, 1916, 142, fig.

Brethes gave a good figure of the genitalia, from which I suspected the synonomy of my *angustifrons;* recently at my request he very kindly sent me type specimens of *caridei*, from which I confirmed it. He found the species a very abundant parasite of *Schistocerca paranensis* Burmeister, in northern Argentina; I described my species from Tifton, Georgia, and Socorro, New Mexico. Thus it appears that the fly extends over the whole range of the locust and at the north considerably farther; in its northern extension it no doubt attacks other species of locust, but no records have been made.

The species belongs to a small group of Sarcophagas which are strictly parasitic as far as known, and usually on locusts. I identified 71 Mexican specimens for Dr. Dampf, and several Guatemalan for Mr. Salas, reared from the Migratory Locust. I found several males sitting on stones on the site where a swarm of locusts had recently departed, in the Valley of the Rio Chixoy near San Cristobal, Guatemala. Considering these facts and the abundance in Argentina, this may be considered the most important known parasite of the locust, with the possible exception of *Oedematocera gilvipes* Coquillett.

Sarcophaga sternodontis Townsend

Sarcodexia sternodontis Townsend, Jour. Inst. Jamaica, i, 1892, 106, and 1893, 221.
Sarcophaga concinnata Williston, Trans. Ent. Soc. London, 1896, 364.—St. Vincent, W. I.
Sarcodexia sp., Nocedo, Proc. Second Pan-Amer. Sci. Congress, iii, 1917, 877.
Sarcophaga sternodontis Aldrich, Sarcophaga and Allies, 1916, 265.—Brauer and Bergenstamm, Zweifl. Kais. Mus., vi, 1893, 193.—Drake, Quart. Bull. State Plant Bd. Fla., iv, 1920, 75, fig.—Johnson, List Ins. of Jamaica, 1919, 439.—Morgan and McDunnough, Farmer's Bull. 819, U. S. Dept. Agr., 1923, p. 6.—Van Zwaluwenberg, Jour. Econ. Entom., xvi, 1923, 227.—Wolcott, Jour. Dept. Agr. of Porto Rico, 1922, 49; List Ins. Porto Rico, 1923, 225.—Greene, Proc. U. S. Nat. Mus., 66, art. 29, 1925, fig.
Sarcophaga sarraceniae Riley, in Comstock, Rept. Commissioner of Agriculture, 1881, 304.—Riley, Fourth Rept. U. S. Entom. Commission, 1885, Appendix, p. 110.

This abundant tropical species comes as far north as the region around the north side of the Gulf of Mexico, and is found at least as far south as Brazil. In the collections sent me for identification by Dr. Dampf, were 201 specimens of this species, mostly reared from the migratory locust, but generally from dead specimens which might not have been attacked by the fly while still alive. It is therefore impossible to say just what importance this species has as a locust enemy. It seems worth while to analyze the available records to get as complete a picture as possible of the larval habits of the species. We have some positive evidence that it is a true parasite, and I think it usually is; but we have also some records which cannot be so interpreted, and many not definite. The crucial question in every case is whether the fly deposited its larvae upon a living insect or a dead and decomposing one. In the United States we have *Sarcophaga helicis* and *sarracenioides*, if not others, which are certainly scavengers at times and at others true parasites; *sternodontis* evidently belongs with these in habit.

We have the following rearing records for *sternodontis:*

ORTHOPTERA

Schistocerca americana Drury, in Florida (Aldrich, 1916).
Dictyophorus reticulatus Thunberg, in Florida (Aldrich, 1916).
Scapteriscus vicinus Scudder, in Porto Rico (Wolcott, 1922).[1]
"Dead Cockroach," in Porto Rico (Unpublished, specimen in Nat. Mus.).
"A large gray-brown mottled Cockroach," in Porto Rico (Unpublished, bred by Dr. F. M. Root; the cockroach is probably *Leucophaea maderae* Fabricius, in the opinion of A. Caudell).
"Large Grasshopper," in Panama (unpublished, reared by August Busck).

HEMIPTERA

Nezara viridula Linnaeus, in Florida (Drake, 1920).
Coreocoris confluentus Say, in Florida (Drake, 1920).
Acrosternum hilaris Say, in Florida (Drake, 1920).
Murgantia histrionica Hahn, in Florida (Drake, 1920).
Euschistus servus, Say in Florida (Drake, 1920).
Belostoma sp. in Panama (unpublished, reared by A. H. Jennings).

LEPIDOPTERA

Alabama argillacea Huebner, in Southern States (Comstock, 1881; Riley, 1885, also an unpublished rearing by G. D. Smith).
Citheronia regalis Fabricius, in Florida (Aldrich, 1916).
Remigia repanda Fabricius, in Porto Rico (Wolcott, 1922).
Cossula magnifica Strecker (unpublished rearing by J. B. Gill).
Phlegethontia sexta Johannsen, in Florida (unpublished record, rearing by F. S. Chamberlin).
Chloridea obsoleta Fabricius, in Salvador (unpublished record, rearing by S. Calderon).

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[1]The name of the fly was omitted in Wolcott's List, but added in his supplement

Chloridea sp., in Florida (unpublished, rearing by J. N. Tenhet).
Erynnis allo Linnaeus (unpublished, reared by J. Zetek) in Canal Zone, Panama.
Heliothis virescens Fabricius, in Southern States (Morgan and McDunnough, 1923).
Laphygma frugiperda Smith and Abbott, in Porto Rico (Wolcott, 1922).
Autographa brassicae Riley, in Louisiana (unpublished, reared by T. H. Jones).
Diatraea saccharalis Fabricius, in Cuba (Van Zuwalenberg, 1923).
Diatraea lineolata Walker, in Mexico (Van Zuwalenberg, 1923).
Acronycta ovata Grote, from Cadet, Missouri (unpublished, reared by Lugger, Bur. Ent. No. 508 L).
Diaphania hyalinata Linnaeus, from Macon, Georgia (unpublished, reared by Pergande, Bur. Ent. No. 225a).
Calpodes ethlius Cramer, in St. Vincent, West Indies (unpublished, reared by F. Watts).
"Caterpillar on Cotton," Tobago, West Indies (unpublished, reared by F. Urich).

COLEOPTERA

Sternodontes damicornis Linnaeus (Townsend, 1892).
Stethoxus foveolatus Reginbart "Especie evolucionada en el cuerpo descompuesto," in Ecuador (unpublished, reared by Professor F. Campos R.).
Lachnosterna portoricensis Smyth, in Porto Rico (Wolcott, 1923).
Strataegus sp., adult, in Jamaica (unpublished, reared by A. H. Ritchie).

MISCELLANEOUS

Human Excrement, in Hayti (unpublished, reared by W. A. Hoffman).
"Larva from Ear of 11-months old Child," in Canal Zone, Panama (unpublished, specimen sent by L. H. Dunn).
"From Case of Myiasis," in Belize, British Honduras (unpublished, sent from Liverpool School of Tropical Medicine).
"On dead Mygale," in Trinidad, West Indies (unpublished, collector unknown).
Centrurus edwardsii Gray (a myriopod), in Jamaica (Townsend, 1893).

The specimens sent by Dr. F. M. Root, were found as larvae in freshly killed cockroaches which were being dissected. The specimen reared by Wilson from *Schistocerca americana* reported by me in 1916, was reared from larvae that emerged after the grasshoppers were killed, pinned, and placed in a tight insect box. These records are sufficient to prove that the fly is sometimes a true parasite, depositing its larvae upon living insects; and there is little reason to doubt that a large proportion of the above records represent cases of genuine parasitism. Several of the other records, especially the rearing from human excrement, indicate that it is sometimes a scavenger.

From the discussion it will be apparent that the value of *sternodontis* as a locust parasite is at present not known.

Brachycoma acridiorum Weyenbergh

Nemoraea acridiorum Weyenbergh, Anales de Agricultura Repub. Argentina, iii, 1875, 85 (also called Doringia acridiorum in same place), figs.—Lahille, Anales

Ministerio de Agricultura, Seccion Zootechnia, etc., 1907, 38, 48, quotes desc. with orig. fig.

Sarcophaga minuta Lahille, ibidem, 82, 86, figs.

Brachycoma acridiorum Brethes, Anal. Mus. Nac. Hist. Nat. Buenos Aires, xxii, 1912, 445, figs., redesc.

The original description was so poor that great uncertainty prevailed for many years as to the correct identification. After Brethes had described *Sarcophaga caridei* in 1906, Lahille was still of the opinion that this species was the same as *acridiorum*, in spite of obvious discrepancies in the original description. So he failed as Brethes believes to observe that one of his own new species, *Sarcophaga minuta*, from the same host, really answered the description of Weyenbergh far better than any other known locust parasite. I follow the conclusion of Brethes in the synonomy, and accept his 1912 determination, from which *acridiorum* is clearly a Brachycoma. He figures the head very well, and Lahille the genitalia.

This appears to be an important parasite of the locust in Argentina, but is not as yet known in tropical North America.

A YEAR'S TEST OF A SO-CALLED "FLY SALT"[1]

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ABSTRACT

A salt mixture termed "fly salt," containing 9.77% free sulphur, has been sold extensively throughout the middle west, under the representation that when fed to cattle, enough sulphur was excreted with the perspiration to prevent flies from biting the cattle, thereby resulting in greater gains to beef cattle and preventing losses in milk flow from fly attacks. Two experiments were carried out by the Kansas State Agricultural College—one at the Hays Station with a herd of 20 high grade Hereford yearlings against a comparable herd kept under the same conditions fed common salt; the other with four dairy cattle at the Kansas Agricultural Experiment Station fed the "fly salt" against animals fed common salt which was sulphur free. The gain in weight in the yearlings in 156 days was approximately equal and the dairy cattle fed the "fly salt" showed a very similar decline in milk flow to the check animals. The salt was, also wholly ineffective as a fly repellent. The fly salt cost six times that of the common salt, and was not relished by the animals.

[1]Contribution No. 359, from the Entomological Laboratory (Dairy contribution No. 58), Kansas State Agricultural College. Valuable assistance was given those responsible for carrying out the tests by Dean L. E. Call, Prof. Geo. A. Dean, Dr. C. W. McCampbell, and Prof. J. B. Fitch. The Hays experiment was carried out by Mr. Aicher; the dairy test by Mr. Lush. Observations on the flies were made by Mr. Smith, who prepared this paper from the three reports.

The wide advertising given a new salt product prepared by one of the largest salt companies in the United States, brought the product rather forcefully to the attention of the Kansas Agricultural Experiment Station. This salt, when fed to cattle, was said to prevent flies from biting the cattle, resulting in less annoyance and greater gains in weight or increased milk production. Many letters inquiring as to the fly repellent qualities of this salt were received. Experimental evidence as to its effectiveness was not available, though the company was reputed to have received testimonials from farmers and cattle-men substantiating its claims of fly-repelling qualities. In order to determine the actual value of the new salt product, a carefully planned test was conducted at the Fort Hays Experiment Station with beef cattle, and a smaller scale test with dairy animals at Manhattan. This is a brief summary of these experiments, and the results obtained. Since it requires considerable time to carry on such tests, since letters of inquiry concerning "fly salt" are still being received, and since further study of this question is not now contemplated, it was thought that these results should be made available by publication.

OUTLINE OF EXPERIMENT AT HAYS EXPERIMENT STATION

In order to arrive at a fair conclusion as to the value of the "fly salt," it was determined that two closely similar lots of cattle would be used — one lot was fed common salt and the other was fed the "fly salt." The cattle were weighed into separate though similar pastures, and weighed out at the close of the experiment. Any significant gain or loss in weight was to be noted at the end of the test. It was felt that if the "fly salt" actually had the quality of preventing flies from biting cattle, it would be registered in a practical way by a greater gain in weight in the group fed the fly repellent salt; it was also to be determined if the gain was sufficient to pay for the increased cost of the new salt. The original plan of the experiment called for exchanging cattle in the pastures every thirty (30) days to overcome any advantage which one group of cattle might have over the other, due to possibly better pasture in one field than in the other, or to more flies in one pasture than the other, but, beginning July 1, the exchange was made every three weeks. The salt was placed in long wooden troughs, and the cattle were given all they would eat. When the cattle were moved to the alternate pastures, the salt was also exchanged. The amount of salt fed was weighed and recorded. Observations as to behavior of the groups were made at convenient intervals throughout the experiment, which lasted from May 1st to October 15, 1926.

TABLE 1.—ANALYSIS OF THE SALT USED IN THESE TESTS

1. Barton's Fly Salt—Analysis by the Federal Insecticide and Fungicide Board, No. 50974, Misc. Div.

Free sulfur, S	9.77%
Chlorine, Cl	53.31
Sodium, Na	34.39
Calcium oxide, CaO	1.55
Carbon Dioxide, CO_2	0.53
	99.55%

Hypothetical Combination of the above in the "fly salt."

Free sulfur	9.77%
Sodium chloride, NaCl	87.89
Calcium carbonate, $CaCO_3$	1.21
Calcium hydroxide $Ca(OH)_2$	1.15
	100.02%

Phosphates—none
Charcoal—none

2. Analysis of the common salt fed, by Prof. W. L. Latshaw, Kansas State Agricultural Experiment Station, Department of Chemistry.

Sulfur	None
Sodium chloride	96.23%
Insoluble matter	1.78
Moisture	0.15
Calcium sulfate (Gypsum)	1.51
Magnesium chloride ($MgCl_2$—6 H_2O)	.03
Total determined	99.70%
Undetermined	.30
Total	100.00%

The salt, when first put on the market, contained approximately 5% of carbon (charcoal), but later this was replaced by 5% lime. It was claimed by the company that the lime had the function of causing the sulphur to be more readily and completely absorbed in the gastro-intestinal tract of the animal, but there is no physiological basis for this claim.

THE EXPERIMENT. Forty well-bred Hereford yearlings—20 steers and 20 heifers—were divided into two groups composed of 10 heifers and 10 steers each. These groups were weighed early in the morning, three days in succession, and the average weight of the cattle for the three-day period computed and accepted as the true initial weight of the groups. The cattle were then taken to the pastures on May 1st—

one group to the so-called "golf" pasture, comprising approximately 280 acres of native prairie grass, and fed "fly salt" manufactured by the Barton Salt Company, and sold to the Experiment Station by the Farmers Co-operative Elevator Company of Quinter, Kansas. The price paid for the salt was $2.40 per hundred pounds, F.O.B. Quinter, Kansas. The other group was taken to the "old dairy" pasture, comprising approximately 275 acres of native prairie grass, and was given common salt, which was a product of this same company and was also purchased locally.

On July 21st, the "old dairy" pasture was abandoned and the herd moved to the "Monument" pasture. This pasture consisted of about 320 acres of native prairie grass and was well supplied with shade and natural creek water. This pasture was somewhat superior to the "golf" pasture, because of a greater amount of shade and the presence of the creek. However, each herd was in the pasture an equal number of days.

Twenty head of Holstein calves were kept with the herd fed common salt until August 11th. On this date they were removed, since there was a theoretical possibility that a larger herd might attract an increased number of flies.

The experiment was begun on May 10, and the cattle were exchanged June 10, July 1, July 21, Aug. 11. Sept. 2, Sept.22, and weighed into the feed lots on Oct. 13, 14 and 15. The average weights for the three-day period being taken as the true weight of the cattle.

EXPERIMENTAL DATA. The dates and amount of salt taken to the the pastures are given below:

TABLE 2.—POUNDS OF SALT FED AND CONSUMED BY THE TWO HERDS IN THE COURSE OF THE EXPERIMENT

Date	Fly salt	Common salt
May 10	50	48.7 } Average consumption
June 10	20	20.3 } for 20 head*
July 21	46	52
Aug. 11	9	16
Sept. 4	16	10
Oct. 13	13 lbs. weighed back	15 lbs. weighed back
Total Consumption	128 lbs.	132 lbs.
Average daily consumption per head	.656 oz.	.676 oz.

*There were 37 head of cattle in this group, in addition to the 20 experimental animals, from May 10 to July 21, inclusive. The salt which the 20 experimental cattle consumed is figured on the basis of the average for the 57 head.

TABLE 3.—WEIGHTS OF CATTLE IN THE TWO LOTS IN THE "FLY SALT" EXPERIMENT

	Fly Salt		Common Salt	
	20 head {10 steers / 10 heifers		20 head {10 steers / 10 heifers	
Total initial weight, May 10	12,300	lbs.	11,910	lbs.
Average weight per animal, May 10	615	lbs.	595.5	lbs.
Total final weight, October 13	15,720	lbs.	15,428	lbs.
Average weight per animal, Oct. 13	786	lbs.	771.4	lbs.
Total gain per lot for 156 days	3,420	lbs.	3,518	lbs.
Average gain per animal for 156 days	171	lbs.	175.9	lbs.
Average daily gain per animal	1.09	lbs.	1.12	lbs.

OBSERVATIONS Definite dates for observations of behavior of the cattle were not provided for in the plan of the experiment, but many visits were made to the pastures during the season. The pastures were somewhat below the average, due to persistent drought. The precipitation records show that the season was 5.44 inches below the normal at the end of September. Flies were not as plentiful as usual, partially due, no doubt, to the shortage of moisture, but there were sufficient numbers to keep the animals fighting them almost constantly.

Observations were made on the behavior of the cattle with reference to flies; long distance observations upon the flies with the aid of field glasses, since the animals were so wild that near approach was impossible; and careful examination of flies caught from the two herds. Horn flies generally predominated, but stable flies were also numerous.

Some actual counts of fly-fighting activities of the animals in both herds were made (see Table 4). The animals were always very restless

TABLE 4.—COMPARISON OF FLY-FIGHTING ACTIVITIES OF SIX ANIMALS IN THE TWO HERDS FOR FIVE-MINUTE INTERVALS

Period activities counted for each animal	Herd fed common salt				Herd fed "fly salt"				
	Switches	Kicks	Head swipes	Position of animal	Time	Switches	Kicks	Head swipes	Position of animal
Aug. 10, '26 10:59–11:04	90	10	5	in herd	9:40–9:45	55	19	8	in herd
Aug. 10, '26 11:08–11:13	93	3	13	slowly walking	9:47–9:52	79	15	1	in herd
Aug. 10, '26 11:20–11:25	70	6	6	in herd	10:58–11:03	160	32	20	sep'r't'd from herd
Average	84.3	6.3	8			98	22	9.6	

and kept milling around in the herd, so that counts for longer periods than used were impossible.

One could readily tell when flies were actually biting the animals and when they were merely resting on the hair of the animal. When biting, the flies were lower down among the hairs. Often they were distinctly tilted forward and their wings were spread out slightly in a manner different from their position at rest.

On August 6, we tried to catch flies from both herds and make counts of the fly population of the two herds and the number of species involved, but the animals were so wild that near approach by any means was impossible. A small barbed wire pen was built in a corner of each pasture, and on Aug. 27, 1926, an attempt was made to collect flies from each herd with the aid of an insect net. Only 121 horn flies were collected from the check herd, and 64 from the "fly salt" herd (see Table 5). The animals milled around in the pens, raising clouds of dust and finally broke through the wire enclosures and escaped. The flies do not represent the population on the animals adequately as to species or numbers. There was a much higher proportion of female than male flies.

TABLE 5.—EXAMINATION OF HORN FLIES TAKEN FROM THE HERDS, AUG. 27, 1926

	Number of flies taken	Number female flies	Number of females with blood	Number of males	Number of males showing blood
Fly Salt herd.....	64	47	27	17	5
Common salt herd.	121	87	45	34	25

No real difference in the fly-fighting activities was observed in the two herds at any time during the experiment. Photographs made at various times during the experiment, of which Plate 17, Figs. 1 to 4, inclusive, are given here, support this statement.

On August 6, it was thought that the coats of the "fly salt" herd were somewhat improved in appearance over the common salt herd. The thirty-seven Holstein calves were with the common salt herd, and it was thought possible that the observers might have been influenced by the presence of the less sleek and glossy Holsteins. This supposed

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EXPLANATION OF PLATE 17

FIG. 1.—The common salt herd in the "Monument" pasture. Aug. 1, 1926.
FIG. 2.—The "fly salt" herd in the same pasture, Aug. 22, 1926.
FIG. 3.—The "fly salt" herd in the "golf" pasture, Aug. 1, 1926.
FIG. 4.—The common salt herd in the "golf" pasture, Aug. 22, 1926.

Note the fly-fighting activities in both herds.
Photographs by Mr. Aicher.

1.

2.

3.

4.

difference in coats was not observed later when the Holsteins were removed. We prefer to leave this question open, as the experiment was not carried out with this point in the plans.

RESULTS AND CONCLUSIONS. It is believed that the very small increased gain made by the common salt cattle shown in Table 2 is within the range of experimental error, and, therefore, we conclude that the showing of the two herds is as nearly equal as one might expect. The average daily gain of the "fly salt" cattle was 1.09 pounds, and that of the common salt cattle was 1.12. pounds.

The results of the experiment indicate rather conclusively that the so-called "fly salt" is not a fly repellent. If it had been, it would have been impossible to catch flies from the bodies of these cattle, approximately fifty per cent of which carried blood in their bodies. Secondly, if the "fly salt" had repelled the flies, the cattle should have registered a greater gain in weight than when fed common salt. It is common knowledge among cattle-men that flies decrease the gains. Since the "fly salt" cattle did not show a gain over the common salt cattle, the so-called "fly salt" is worth no more per pound as salt for cattle than is common salt. The 'fly salt" at $2.40 per hundred pounds cost six times more than the common salt at forty cents per hundred.

THE DAIRY EXPERIMENT. In this test, the results of feeding this same salt to dairy cattle were studied. The "fly salt" used in this part of the experiment contained some charcoal, and was very dark in appearance. The analysis of this salt, as given in the Report of Analysis of Official Samples of Livestock Remedies, July 1, 1925–26, by the Kansas State Board of Agriculture, Vol 45, p. 34, No. 178, is as follows: Salt 85.35%, sulphur 10.52%, charcoal 2.8%, moisture by difference 1.33%.

PLAN. Four cows were fed one and one-half per cent Homestead Fly Salt in the grain ration as compared to three check animals and the rest of the herd which received one and one-half per cent normal granulated salt in the ration. The four cows also had access to individual salt bowls at milking time which contained Homestead Fly Salt. No other salt was available, the plan being to obtain the maximum consumption of Homestead Fly Salt. The four cows used were comparable in breed and lactation period. They were handled and milked with the rest of the herd, being on pasture from 7:00 a.m. to 2:00 p.m., and during the night. The majority of the feed was consumed in the barn at milking time where silage and grain were fed.

Samples of milk from each of the cows receiving "fly salt" and from three check cows were separately cooled and observed for two days

previous to the start, and during 40 days of the experiment. The experiment started June 7th, with "fly salt" being given for the first time.

RESULTS The production of milk by 10-day periods for each lot is given in Table 6.

TABLE 6.—MILK PRODUCTION IN POUNDS OF MILK IN THE TWO LOTS OF COWS FOR 40 DAYS

Lot	Prelim-inary 10 days	First 10 days	% De-crease	Second 10 days	% De-crease	Third 10 days	% De-crease 30 days	Fourth 10 days	% De-crease 40 days
Fly salt group..	481.0	378.9	21.2	310.6	35.4	271.1	43.6	228.8	52.4
Check lot.	421.4	326.1	22.6	276.7	34.3	250.4	40.5	217.0	48.5
Difference.	59.6	52.8		33.9		20.7		11.8	

The decline of 252.2 pounds of milk in 40 days for the three cows receiving "fly salt" as compared to the smaller decline of 204.4 pounds in the check lot for the same period, indicates that the "fly salt" was no more effective in preventing the usual decline in the milk flow than was ordinary salt. This is contradictory to the advertisement of the manufacturers of this product. The estimated average number of flies on the left side of representative animals of each group is given in Table 7.

TABLE 7.—AVERAGE NUMBER OF FLIES PER DAY ON EACH COW WHILE IN THE STABLE

Lot	First 10 Days	Second 10 days	Third 10 days	Fourth 10 days	Fifth 10 days	Ave. for 50 days
Fly salt.....	35	37	18	12	10	22
Check.....	29	34	18	16	14	22

The smaller number of flies during the last 30 days can be attributed to the extremely hot and dry weather with lessened opportunity for breeding and possibly fewer flies. It was noticed that on extremely hot days the flies did not attack the cows, but withdrew to the north wall of the barn.

It was suggested by a salesman of the "fly salt" company that the flies were not annoying the cows, but simply resting. It was determined that the species of flies in the stable in order of abundance were the stable fly, horn fly and house fly. It was found by mashing the first two species of flies collected on the experimental animals that a rather high percentage of them contained blood.

INFLUENCE OF FLY SALT ON THE TASTE OF THE MILK. In checking the effect of the "fly salt" on the taste of milk, surprising results were obtained. All of the samples were normal in taste during the preliminary two days,

but by the afternoon milking of the first day "fly salt" was given, two of the three samples were distinctly salty and continued to be off flavor. Each sample was tasted immediately after cooling and 24 hours later, in order to notice any further change. The results are given in Table 8.

TABLE 8.—EFFECT OF SALT ON FLAVOR OF MILK

	Group 1—Fly salt cows				Group 2—Common salt cows				
Period	Cow 1	Cow 2	Cow 3	Cow 7	Cow 4	Cow 5	Cow 6	Total	
Preliminary 2 days	3 tests	3 tests	3 tests		3 tests	3 tests	2 tests	17 tests all normal	
								Group 1	Group 2
June 7–28									
Normal	3	31	0	Dry	27	18	21	34	66
Salty	40	12	43		1	10	1	95	12
June 29–July 5[1]									
Normal	0	14	6		13	10	11	20	34
Salty	14	0	8	Dry	1	4	3	20	8
July 19–22									
Normal		6	0	7		7	1	13	8
Salty		1	7	0		0	6	8	6
Total Normal								67	108
Total Salty								123	26

[1]Cows 4 and 5 given one ounce salt per feed.

At no time during the three months were the cows observed in the act of eating "fly salt" from the salt bowls, although there was a slight loss when weighed back September 5. The "fly salt," when offered to young stock not receiving other salt, was consumed reluctantly, three days elapsing before it was touched.

RESULTS. As a result of a three months' trial with four cows fed Homestead Fly Salt, it was observed that those cows did not differ materially, in production of milk or freedom from fly annoyance, from other cows fed normal salt and handled in a similar manner.

The three cows that were milking declined 52.4 per cent in milk flow from various causes as compared to a decline of 48.5 per cent for three similar cows fed normal salt during the period of 40 days.

The average number of flies observed daily on the left side of each animal averaged the same for each lot for the 50 days observations were made.

It is possible that fly salt has an injurious effect on the flavor of the milk. We do not consider this point as definitely proved, as there are certain uninvestigated physiological problems involved. It was discovered in September that cow No.1 had mammitis, which normally renders the milk bitter or salty to the taste. But, omitting the samples

obtained from cow No.1, we find that in the "fly salt" lot, 67 of the 133 samples were salty as compared to 26 out of 134 in the normal group.

The Metabolism of Sulphur in Mammals

Sulphur is the ingredient in the salt alleged to repel the flies. It is, however, well known to physiologists that elemental sulphur is not absorbed in the alimentary tract, except in minute quantities. Sulphur is absorbed by the body chiefly in the form of the two amino acids—cystine and cysteine decomposition products of protein. The sulphur probably practically all passed through the body unchanged. The amount of sulphur in the body remains relatively constant, and is not greatly influenced by the sulphur containing proteins in the diet. Cushney (1918)[1], states that while the greater part of free sulphur consumed is excreted unchanged, some of it forms sulphides in the mucous membrane of the intestine, and these cause irritation. "Some 10–20% of sulphur taken by way of the mouth is absorbed as sulphides, which is excreted to a small extent by the lungs . . . and to a much larger extent by the urine as sulphates and in organic combination." There is, therefore, no physiological basis whatever for expecting "fly salt" to be excreted in sufficient quantities with the perspiration to repel flies. While it is possible that some of the sulphur compounds may be excreted with the perspiration, there is no scientific evidence that this is the case. The first opinions expressed by officials of this institution were based on this knowledge, but tests seemed advisable because of users' testimonials.

General Results and Conclusions

As a result of these two tests, we conclude, in the case of this "fly salt," that:

1. It was without value for the purpose recommended. Animals fed all the salt they would eat were tormented by flies to the same extent as those fed common salt, and that approximately the same percentage of flies caught on the animals contained blood which was unquestionably derived from the cattle.
2. There was no gain in weight over those fed ordinary salt as a result of feeding "fly salt," and the milk flow was not appreciably influenced by it.
3. Cattle did not relish it as much as they did ordinary salt.
4. There is a possibility in some animals or under some conditions of influencing the taste of the milk. The salty milk detected during the dairy test is an apparently new problem, and it is not understood.

[1]Cushny, Arthur H. A text book of Pharmacology and Therapeutics. . .Lea and Febiger, 1918. (Reference on p. 94–95.)

FURTHER INFORMATION ON A CONTACT SPRAY FOR THE CONTROL OF THE JAPANESE BEETLE (*POPILLIA JAPONICA* NEWM.[1]

By E. R. VAN LEEUWEN, *Associate Entomologist*, and P. A. VAN DER MEULEN, *Agent*, *Bureau of Entomology, United States Department of Agriculture.*[2]

ABSTRACT

The purpose of this paper is to record the improvement made in the sodium oleate-oleoresin of pyrethrum spray for the control of the Japanese beetle by the addition of sodium silicate.

INTRODUCTION

In a preliminary report,[3] a tentative formula for a contact spray consisting of sodium oleate and oleoresin of pyrethrum flowers, was presented. Data on its use in controlling the Japanese beetle were included. The purpose of this paper is to give additional data on the improvement of the spray, based on experiments conducted during 1926.

ISECTICIDAL VALUE OF CONTACT SPRAY

During the past beetle season, according to the reports of several manufacturers of the spray, approximately twenty-two thousand dollars worth of the contact spray consisting of the oleoresin of pyrethrum flowers and sodium oleate was used throughout the heavily infested section of the beetle area with very satisfactory results. It was estimated that millions of beetles were destroyed by use of the spray. The past season's experience with the contact spray again demonstrated the fact, pointed out in the earlier report, that the controlling factor in the percentage of kill obtained with a spray of this type against the Japanese beetle, is the thoroughness with which the application is made. The size and structure of the beetle, as well as the nature of the effect of a spray of this character upon the beetle, necessitates that the application be thorough.

In several cases low kills were reported from the use of the spray. Upon investigation it was determined that the lack of a sufficient coating of this spray mixture to cover the beetles was accountable for this. These few cases of low kill resulting from inefficient mechanical operation of the spray can be more readily understood when one considers

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[1]Contribution No. 23 of the Japanese Beetle Laboratory, Riverton, N. J.

[2]The writers are not attempting in this paper to set forth a finished formula; but, in view of the interest shown in a spray of this type, the data obtained from laboratory tests are presented at this time.

[3]Van Leeuwen, E. R. A contact spray for the control of the Japanese beetle. Jour. Econ. Ent., Vol. 19, No. 5, Pages 786–790. 1926.

that most of the spray was used in the residential districts of Philadelphia, Pa., and Camden, N. J., by people who lacked experience in the method of applying sprays or were not acquainted with the results to be expected from the application of a contact spray.

It has been proved that a contact spray has considerable value in combating the Japanese beetle, and investigations were therefore continued during the 1926 beetle season with sprays of this nature.

Purpose of The Tests

Besides the testing of materials of promising and of unknown value for sprays against the beetle, several materials were added to the combination of oleoresin of pyrethrum flowers and sodium oleate in an endeavor to increase its toxicity, to cheapen its production, and to improve its effectiveness in general.

Experimental Procedure

A uniform method of testing the sprays in cages, as recorded in the report on the contact formula, was used.[3] The conditions under which the sprays were applied were similar for each series, this arrangement being necessary for the purpose of comparing the effectiveness of the different materials.[4] Since the original formula, when applied to beetles in cages, gave nearly 100 per cent kill, it was necessary, for purposes of comparison of the various materials, to use a less concentrated solution. The formula to which the materials were added will hereafter be referred to as Formula A and is as follows:—An alcoholic extract of pyrethrum flowers 9½ ounces, sodium oleate 86½ ounces, and water 100 gallons. The materials which were thought to be of value in improving the formula and tested were as follows:—Kerosene, various grades of cresylic acid, glycerine, carbon tetrachloride, sodium silicate and gum arabic. With the exception of the tests made with sodium silicate and Formula A, the results were more or less negative, and since no apparent improvement in the toxicity of the spray resulted from the addition of the other materials, only the results obtained with the sodium silicate are given. The results obtained by the addition of the sodium silicate to Formula A are given in Table 1, as well as the results from tests with untreated beetles and beetles treated with Formula A without the sodium silicate. The "sodium silicate," as used in this spray, refers to a solution of the following composition:

Na_2O	9.01%
SiO_2	28.35%
H_2O (by diff.)	62.64%

[4]The writers wish to acknowledge the assistance of Mr. G. A. Fails in carrying out the spray tests.

TABLE 1.—COMPARISON OF RESULTS FROM TESTS WITH VARIOUS AMOUNTS OF SODIUM SILICATE ADDED TO SODIUM OLEATE-OLEORESIN OF PYRETHRUM SPRAY

Series No.	Date	Material Used																	
		Formula A[1]			Formula A and sodium silicate solution 3 fluid ounces			Formula A and sodium silicate solution 6 fluid ounces			Formula A and sodium silicate solution 9 fluid ounces			Formula A and sodium silicate solution 12 fluid ounces			Untreated beetles (Check)		
		Total No. of beetles	Mortality		Total No.	Mortality		Total No.	Mortality		Total No.	Mortality		Total No.	Mortality		Total No.	Mortality	
			Per cent			Per cent			Per cent			Per cent			Per cent			Per cent	
			24 hrs.	48 hrs.		24 hrs.	48 hrs.		24 hrs.	48 hrs.		24 hrs.	48 hrs.		24 hrs.	48 hrs.		24 hrs.	48 hrs.
1	Aug. 11	192	31	59	312	36	57	176	81	98	181	63	82	148	89	95	191	3	12
2	Aug. 12	201	79	85	284	68	81	203	93	96	192	71	87	206	76	87	189	3	12
3	Aug. 14	185	32	42	397	86	93	383	77	87	393	76	86	401	80	89	193	5	10
4	Aug. 16	422	41	68	388	46	78	386	62	86	286	74	86	193	59	88	190	6	26
5	Aug. 18	363	29	53	395	11	32	426	43	55	391	44	57	361	62	86	197	5	22
6	Aug. 19	198	58	80	215	33	51	207	71	91	326	82	97	352	77	87	204	5	12
7	Aug. 24	388	74	86	395	62	80	384	75	87	384	70	93	397	69	89	98	19	37
Average for series			49	67		48	68		71	85		68	84		73	88		6	18

[1]Formula A is as follows: An alcoholic extract of pyrethrum flowers 9½ ounces, sodium oleate 86½ ounces and water 100 gallons.

Results

For the purpose of summarizing the results and drawing deductions an average percentage of kill for 24 hours and 48 hours after application is calculated from all of the observations throughout the year's tests. The data in Table 1 show strikingly the effect of adding 6 ounces of sodium silicate solution to the spray composed of oleoresin of pyrethrum and sodium oleate. The results in percentage of kill of the different solutions as shown in Table 1 are as follows:—Formula A which contained no sodium silicate whatsoever gave an average kill of 49 per cent at the end of the 24 hour period after treatment and 67 per cent for the total period of 48 hours. Formula A to which three ounces of sodium silicate solution had been added gave 48 per cent kill for the 24 hour period and 68 per cent within 48 hours. An increase in the sodium silicate solution content to 6 ounces gave an average kill of 71 per cent for the first 24 hours after the beetles were sprayed and 85 per cent at the end of a 48 hour period. Thus it is shown that 6 ounces of sodium silicate solution added to formula A increased its toxicity by 22 per cent and 18 per cent for the 24 and 48 hour periods, respectively. As will be seen by an examination of the death rate among the untreated beetles, an average of 6 per cent died in 24 hours and 18 per cent within 48 hours. By increasing the sodium silicate solution in the spray to 9 ounces, the average kill obtained was 68 per cent for the 24 hour period and 84 per cent within 48 hours. Twelve ounces of sodium silicate solution added to formula A resulted in an average kill of 73 per cent and 88 per cent for the 24 and 48 hour periods, respectively. From these results it will be seen that the greatest efficiency of the sodium silicate, under the conditions reported above, centers close to the 6 ounce rate.

Laboratory studies are being made on the physical and chemical structure of the various combinations of the soaps and sodium silicate in an endeavor to find a satisfactory explanation for the results recorded above.

Summary

While a contact spray of oleoresin of pyrethrum flowers and sodium oleate has proved effective in killing the Japanese beetle, further experiments were made to increase its toxicity, to lessen its cost, and to improve its effectiveness in general.

The addition of 6 fluid ounces of sodium silicate solution to a mixture composed of 86½ ounces of sodium oleate, 9½ ounces of oleoresin of pyrethrum flowers and 100 gallons of water resulted in a very striking increase in toxicity.

Further studies are contemplated to determine the physical and chemical structure of the spray in order to utilize the sodium silicate more effectively in combating the Japanese beetle.

A STUDY OF ARSENICAL RESIDUES ON APPLES IN PENNSYLVANIA WITH RESPECT TO EFFICIENT SPRAYING PRACTICES[1]

By G. F. MACLEOD, D. E. HALEY and R. H. SUDDS, *The Pennsylvania State College, State College, Penna.*

ABSTRACT

Insect species attacking apples in Pennsylvania necessitated six arsenical spray applications. The omission of one or more of these treatments resulted in increased injuries to the fruits. Satisfactory protection was obtained during 1926 without excessive arsenic occurring on the apples at harvest time. Rains in excess of normal tended to reduce the amount of spray deposit. Visibility of materials was no indication of the relative amounts of residual arsenic.

INTRODUCTION

Apples of the southern and southeastern counties of Pennsylvania are subject to attacks of several insects which ordinarily feed extensively during the middle and late summer months. Codling moth outbreaks occur late in August in some years. *Eulia velutiana* Walker, the red-banded leaf-roller; *Archips rosaceana* Harris, the oblique banded leaf-roller; and *Amorbia humerosana* Clemens, are late feeders of importance, some individuals appearing in October or during November.

The damage incurred from these insects is often a source of annual losses to fruit growers, and late summer sprays containing lead arsenate are sometimes necessary for the complete protection of apple fruits from insect injury. As a result, a rather heavy coating of material sometimes remains on the fruits. A few shipments of apples have been rejected or seized, both at home and abroad because of excessive spray residues. The financial losses and embarrassment sustained by growers on account of these procedures, together with the absence of local information concerning arsenical deposits led to a study of these conditions by the Department of Entomology Extension of the Pennsylvania State College. The analyses of residues were made by the Department of Agricultural and Biological Chemistry.

OBJECT OF THE STUDY

The object of this study was to ascertain quantitatively the amount of residual arsenic present on apples which had received the minimum

[1]Approved by the Director of the Experiment Station as Technical Paper No. 434.

quantity of spray material required for the adequate protection of the fruits. This work comprised two phases,—(1) the determination of what constituted the minimum amount of arsenical spraying for complete protection and (2) the determination of arsenic in spray deposits.

Arsenical Spraying Practices During 1926

The spraying schedule as outlined in Table 1 includes the dates of applications which were advised in 1926.

Discussion

From Table 1 it will be observed that six applications of arsenical sprays were used in these sections. No arsenical was used in the delayed dormant period where oil sprays were applied. In either instance, however, the fruits received four poison sprays from the time of the petal fall treatment to the end of the spraying season.

The advisability of using arsenicals at the periods stated and in the amounts indicated is evident from the nature of the problems involved. Tent caterpillars, bud moths and leaf-rollers were unusually numerous during 1926, and a reduction in the numbers of the first generation assists greatly in preventing late summer injuries to the fruit.

Codling moth adults did not emerge in these counties at the time of the petal fall application, but ten to fifteen days later they appeared in large numbers. Coincident with this emergence, the plum curculio gave promise of unusual damages to fruits. These two factors were responsible for an emergency spray warning noted in Table 1. The usual cluster apple and summer applications were required by the presence of apple scab, together with the continued activities of the plum curculio, our common leaf-rollers, and the codling moth. The summer application was made from the middle to the last of July. Only two of the applications advised contained a spreader.

Effectiveness of Spray Applications in Commercial Orchards

The percentages of clean fruits recorded in Table 2 are only of apples which were not injured by insects ordinarily controlled by lead arsenate. As far as possible, Stayman apples were selected from vigorous, well cared-for trees in the prime of bearing condition. Orchard 16 received an application of sulfur-lead arsenate dust at the time of the last treatment. This represented an effort on the part of the grower to avoid excessive spray residues, and it is interesting to note that there was no visible residue on these apples, (see Table 3, sample No. 11). The degree of protection in this orchard was considerably less than that obtained where a liquid application was made. Orchard 17 did not

TABLE 1.—ARSENICAL SPRAY APPLICATIONS ADVISED IN 1926

Period	Materials	Insects present	Dates of application by counties							
			Berks	Bucks	Chester	Delaware	Lebanon	Lehigh	Montgomery	Philadelphia
Delayed Dormant	Lime sulfur diluted to 1.03 Sp. gr. Lead arsenate 3 lbs. per 100 gals. Nicotine 1 pint per 100 gals.	Apple aphids Early worms Scale Tent caterpillars	April 21	April 22	April 19	April 19	April 21	April 23	April 19	April 19
Pre-Blossom	Lime sulfur diluted to 1.008 Sp. gr. Lead arsenate 3 lbs. per 100 gals. Nicotine 1 pint per 100 gals.	Apple scab Bud moths Leaf-rollers Apple aphids	May 6	May 5	May 4	May 3	May 6	May 7	May 4	May 3
Petal Fall or Calyx	Same as pre-blossom	Apple aphids Red bugs Codling moth Curuclio Apple scab	May 17	May 17	May 16	May 14	May 17	May 19	May 16	May 14
Emergency	Lime sulfur diluted to 1.008 Sp. gr. Lead arsenate 3 lbs. per 100 gals. Spreader	Apple scab Curculio Codling moth Apple scab	May 27	June 1	May 27	May 27	May 28	June 8	May 27	May 28
Cluster Apple	Same as emergency	Curculio Codling moth Leaf-rollers	June 16	June 8	June 8	June 8	June 15	June 17	June 8	June 8
Summer	Lime sulfur and Lead arsenate as in emergency	Codling moth Leaf-rollers	July 30	July 18	July 16	July 16	July 17	July 19	July 16	July 16

receive the emergency application. As a result, in this orchard there was an increased amount of curculio injuries. Orchard 18 was used to determine the intensity of insect injuries. The figures, Table 2, indicate the efficiency of the advised spraying practices.

TABLE 2.—RESULTS OF COMMERCIAL SPRAYING FOR FRUIT PROTECTION

Orchard No.	Treatment*	Classification of Injuries† Plum Curculio Per cent	Fruit Worms Per cent	Codling Moth Per cent	Injured Fruit Per cent	Clean Fruit Per cent
1	As advised	1	0	0	1	99
2	As advised	0	2	2	4	96
3	Sprayed Personally	5	0	2	7	93
4	As advised	2	6	0	8	92
5	As advised	6	4	2	12	88
6	As advised	7	5	3	15	85
7	As advised	11	4	2	17	83
8	As advised	13	4	0	17	83
9	As advised	8	6	4	18	82
10	As advised	10	5	3	18	82
11	As advised	8	7	5	20	80
12	As advised	14	0	6	20	80
13	As advised	15	1	4	20	80
14	As advised	10	2	12	24	76
15	As advised	16	5	5	26	74
16	Last application a dust	14	4	11	29	71
17	Emergency application not used	15	12	6	33	67
18	Three applications at random	20	13	19	52	48

*"As advised" means that the orchard was treated according to the recommendations of the spraying service.

†The classification "Fruit Worms" is used to include all injuries caused by species such as green fruit worms, bud moths, and leaf-rollers.

The data expressed in Table 2 were obtained from 18 different orchards located in six different counties of southeastern Pennsylvania. In general, the results indicate that the number of arsenical treatments suggested were sufficient to protect the fruit. It is also evident that any diminution in the numbers of treatments could not have been expected to afford adequate fruit protection.

Arsenic Content of the Spray Residues

Methods of Sampling

Samples consisting of 24 apples each, were selected in the orchards represented in Table 2 and in other plantings. A total of 33 orchards in 17 counties contributed samples for analyses. In picking the fruits those which had the heaviest spray deposit were secured. A square of heavy paper was placed around each apple and the fruit carefully removed from the branch. Each sample was packed in a cardboard carton and sent to the laboratory. All fruits were collected from the lower branches, where the maximum amounts of visible residue were found on the fruit before it was handled. A second collection was made from the same orchards, taking fruits from containers ready for market.

Methods of Analysis

The different samples used were weighed before treatment for the removal of arsenic, and the AS_2O_3 calculated per pound of fruit.

The modified Gutzeit method[2] was used and gave satisfactory results. In removing the total quantity of arsenic from the surface of the apples it was found that a 7 per cent ammonium hydroxide solution gave approximately as satisfactory results as were obtained by the use of a mixture of hot concentrated nitric and sulfuric acid. In either case, care was taken to remove any residue from the stem, cavity and calyx of each apple, and the surface was thoroughly washed with water. The solution obtained was then made up to volume and an aliquot was taken for analysis.

All determinations were made under the same conditions as to length of time, temperature, acidity, amount and surface area of the zinc employed. The results obtained are given in Table 3.

The amount of rain fall is known[3] to have a direct influence on the amount of arsenic found in spray residues and should be considered in connection with the analysis. The samples analyzed were exposed to rains which are indicated in the graph, Table 4. During the months of April, May, June and July there was a total deficiency in rainfall of 4.73 inches, but there was an excess of 5.12 inches through August, September and October.[4] Since but three of the samples analyzed were sprayed after July 31, the majority of the fruits were subjected to rains in excess of the normal precipitation.

[2]Scott, W. W., 1917, Standard Methods of Chemical Analysis. P. 40. New York City.

[3]O'Kane, W. C., Hadley, C. H., and Osgood, W. A., Bulletin No. 183, N. H. Agricultural Experiment Station.

[4]U. S. Weather Bureau, Philadelphia, Pa., 1926.

TABLE 3.—RESULTS OF ARSENICAL ANALYSES

Sample No.	Location	No. Ars. sprays	Date last application	Amount spray residue	Date collected	Amount AS_2O_3 per lb. apples
	County					Grains
1	Montgomery	3	July 16	Light to medium	Oct. 6	0.0019
2	Montgomery	3†	July 16	Heavy	Oct. 6	0.0026
3	Bucks	2	June 1	Light	Oct. 7	0.0003
4	Bucks	3	July 18	Light	Oct. 7	0.0010
5	Lehigh	2 & 1 dust*	July 19	Light	Oct. 8	0.0004
6	Lehigh	3	July 19	Heavy	Oct. 8	0.0013
7	Philadelphia	3	July 16	Heavy	Oct. 12	0.0018
8	Philadelphia	3	July 16	Heavy	Oct. 12	0.0014
9	Berks	3	July 30	Heavy	Oct. 14	0.0004
10	Berks	3	July 30	Heavy	Oct. 14	0.0004
11	Delaware	2 & 1 dust*	Aug. 6	Very light	Oct. 19	Trace
12	Delaware	2 & 1 dust*	July 15	Medium	Oct. 19	0.0004
13	Lebanon	3	July 17	Light	Nov. 4	0.0004
14	Lebanon	3	July 17	Light	Nov. 4	0.0020
15	Adams	4 dusts	June 30	None	Oct. 8	Trace
16	Adams	3 sprays	July 1	Light	Oct. 8	0.0002
17	Adams	4	July 23	Heavy	Oct. 8	0.0009
18	Franklin	2	July 2	Medium	Oct. 9	Trace
19	Franklin	4	July 20	Heavy	Oct. 9	0.0007
20	Franklin	4	July 26	Heavy	Oct. 9	0.0013
21	Franklin	4 & 1 dust*	Aug. 1	Light	Oct. 9	0.0005
22	Lycoming	3	July 31	Heavy	Oct. 12	0.0007
23	Lycoming	3	July 31	Medium	Oct. 12	0.0004
24	Lycoming	3	July 31	Heavy	Oct. 12	0.0005
25	Lycoming	4	Aug. 2	Very heavy	Oct. 12	0.0059
26	Lycoming	4	Aug. 2	Very heavy	Oct. 12	0.0057
27	Lycoming	4	Aug. 2	Very heavy	Oct. 12	0.0059
28	Lycoming	4	Aug. 2	Very heavy	Oct. 12	0.0041
29	Carbon	3	July 1	Very light	Oct. 14	0.0008
30	Carbon	3	June 11	Very light	Oct. 14	Trace
31	Carbon	3	July 7	Very light	Oct. 14	0.0005
32	Schuylkill	3	July 10	None	Oct. 15	0.0005
33	Schuylkill	4	July 15	Light	Oct. 15	0.0010
34	Mifflin	4	July 26	Light	Oct. 22	0.0005
35	Mifflin	4	July 26	Medium	Oct. 22	0.0007
36	Mifflin	4	July 26	Heavy	Oct. 22	0.0017
37	Juniata	3	July 3	Medium	Oct. 22	0.0007
38	Lawrence	3	Aug. 5	Medium	Oct. 23	0.0012
39	Lawrence	3	Aug. 5	Medium	Oct. 23	0.0010
40	Washington	3†	Aug. 1	Light	Oct. 23	0.0004
41	Washington	3	Aug. 1	Light to Medium	Oct. 23	0.0035
42	Fayette	3	Aug. 1	Medium	Oct. 22	0.0019

*Last application.

†Colloidal lead arsenate.

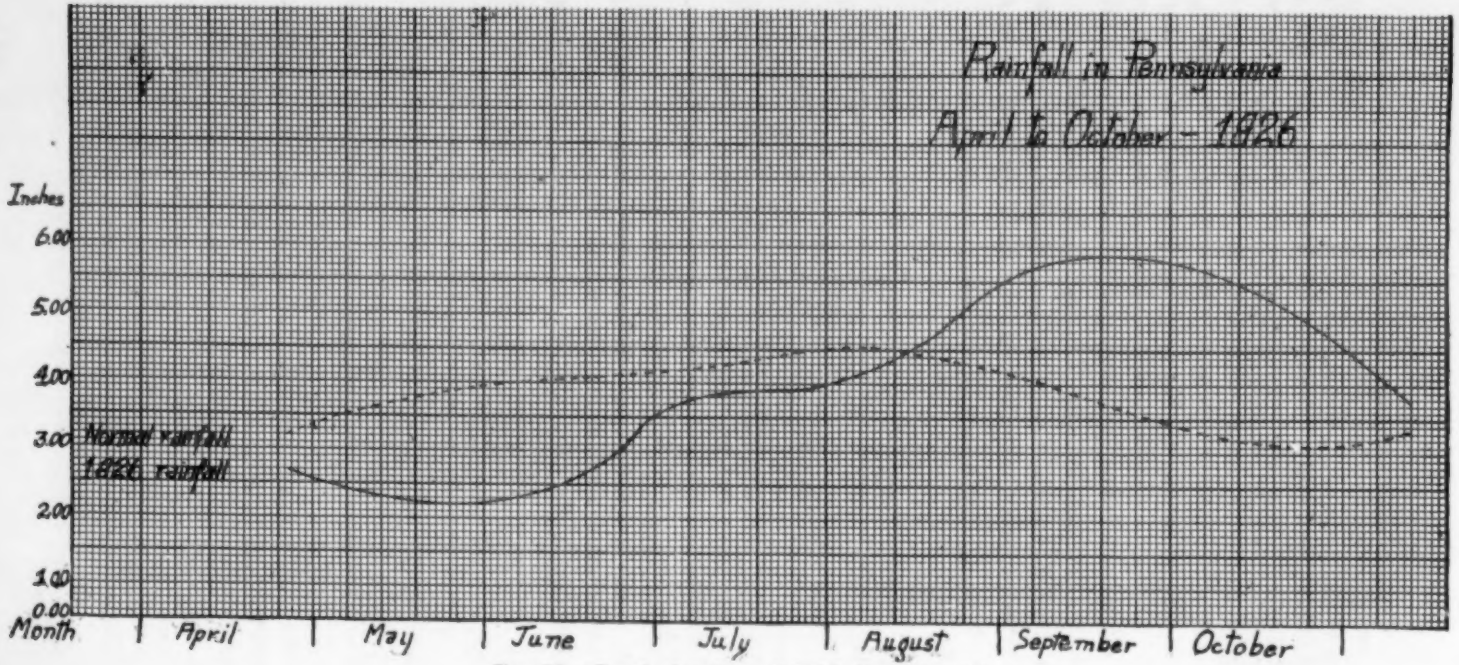


FIG. 23.—Graph showing rainfall in Pennsylvania

The analytical findings seem to justify certain conclusions. Arsenic, with but one exception, was found on all samples tested. In no case was there found an amount of arsenic equivalent to 1/100 of a grain per pound of apples, the stated British tolerance. These results, however, were all made previous to any handling of the fruit. When the apples were presented for public consumption the amount of arsenic found was reduced to a trace, (see Table 5).

It was found that the relative quantity of visible spray residue did not serve as an index of the *quantity* of arsenic present. As a matter of fact, as much arsenic was found on apples having no visible spray residue, as on those having considerable residual material on their surface.

Different samples obtained from the same orchard and receiving the same treatment showed a uniform quantity of arsenic present.

TABLE 5.—AMOUNTS OF ARSENIC ON FRUITS BEFORE AND AFTER HANDLING

Sample No.	Amount of visible spray residue		Amount of arsenic (AS_2O_3)	
	Before handling	After handling	Before handling	After handling
			Grains per pound	
1	Light	None	0.0019	Trace
2	Heavy	Very light	0.0026	Trace
3	Light	None	0.0003	Trace
4	Light	None	0.0010	Trace
5	Heavy	None	0.0004	Trace
6	Heavy	None	0.0004	Trace
7	Light	None	0.0004	Trace
8	Light	None	0.0020	Trace
9	Light	None	Trace	Trace
10	Light	None	0.0004	Trace

SUMMARY

Under conditions prevailing in Pennsylvania during 1926, it was found commercially feasible to produce marketable apples without objectionable spray residues. Sprays were applied with but little, if any, deviation from the usual procedure and no supplementary preparation of the fruit was necessary.

Visibility of spray deposits on these apples was no indication of the relative quantities of the poison.

The authors recognize that there were imperfections of methods in sampling and analysis, unusual climatological conditions, and that the study was of comparatively short duration. The results are presented, however, as a regional contribution to a subject of national interest.

REDUCING THE COST OF NICOTINE SULPHATE SPRAYS

By H. N. WORTHLEY, *Assistant Professor of Entomology Extension, Pennsylvania State College*[1]

ABSTRACT

A reduction in the cost of nicotine sprays is sought by the use of "liberators." In this connection the efficiency of some common chemicals is recorded and data presented suggesting that their use in nicotine sulphate sprays will allow a reduction in dosage of nicotine.

INTRODUCTION

It has been known for many years that decoctions of tobacco in water possess insecticidal properties. Bourcart,[2] in discussing tobacco (pp. 371–375), makes mention of the tobacco juices sold by the French government, and differentiates between "new juice" and "old juices." The former contains up to 10 per cent of nicotine, while the latter contain only about one-fifth as much. He also gives the formulas recommended by several European investigators for the home preparation of spray solutions from these juices.

In the United States, solutions of nicotine sulphate $(C_{10}H_{14}N_2)_2.(H_2SO_4)$ guaranteed to contain not less than 40 per cent of nicotine have been placed on the market in recent years, and are now the standard form for the out-of-doors application of nicotine. Nicotine sulphate is a stable salt and does not deteriorate in the package. In consequence, dosage requirements do not have to be figured for each lot, as with the French tobacco juices. This is an obvious practical advantage in favor of the stable product. This advantage, however, has an attendant disadvantage. Solutions of nicotine sulphate when sprayed upon the foliage of plants do not give up their nicotine to the atmosphere as freely as do solutions of uncombined nicotine. The importance of this fact is now recognized, for McIndoo[3] has shown that the action of nicotine as an insecticide is due largely to the fumes, which enter the tracheae of insects and exert a paralyzing action on the nervous system.

With this in mind, Headlee and Rudolfs,[4] and De Ong[5] have demon-

[1]Contribution from the Department of Entomology, Massachusetts Agricultural Experiment Station. A report of progress in a study interrupted by the resignation of the writer on March 1, 1925.

[2]Bourcart, E. Insecticides, Fungicides and Weed Killers. Scott, Greenwood and Son. 1913.

[3]McIndoo, N. Effects of Nicotine as an Insecticide. Jour. Agr. Res., V. 7, pp. 89–122, 1916.

[4]Headlee, T. J., and Rudolfs, W. Some Principles which Underlie the Making and Use of Nicotine Dust. N. J. Agr. Exp. Sta. Bull. 381, Jan., 1923.

[5]De Ong, E. R. The Relation Between the Volatility and Toxicity of Nicotine in Sprays and Dusts. Jour. Econ. Ent., V. 16, No. 6, pp. 486–493, Dec., 1923.

strated that the killing efficiency of nicotine in dust and spray mixtures against aphids varies directly with the rate at which gaseous nicotine is evolved. De Ong, working with a pure nicotine sulphate of his own manufacture, showed that certain alkalis, by combining with the sulphuric acid, hasten the evolution of gaseous nicotine from spray mixtures of nicotine sulphate.

The Problem

"To reduce the ultimate cost to the consumer we must do one of two things—reduce the cost of raw materials—or attain the same result by making the same materials of the same cost more effective, go farther, or have greater lasting effect. Chief among the materials which are objected to because of their cost are arsenic and nicotine."[6]

Failing a reduction in the cost of manufacture of nicotine, the grower, by the use of alkalis, should be able to increase the efficiency of his nicotine sulphate sprays. The question naturally arises, "If nicotine sulphate at a given dilution is 100 per cent effective, should not the addition of an alkali by increasing the rate of evolution of nicotine allow a reduction in the dosage?

Quantitative Studies of Nicotine Evolution

In order to discover the respective merits of a number of common chemicals as liberators of nicotine from spray solutions of nicotine sulphate, a series of tests was run, in which 10 c. c. samples of different spray mixtures were exposed in drops on glass plates in a room kept at a constant temperature. At definite intervals of time, the residues were carefully washed from the plates with very dilute hydrochloric acid and anlayzed for nicotine by the Chapin method,[7] using his alternative method (ibid; p. 13) of weighing the anhydrous salt. By this procedure a curve could be plotted for each liberator investigated, showing the per cent of nicotine evolved after different intervals of time.[8] This is the method followed by De Ong.[5]

A list of the chemicals tried as liberators, with the amounts of each necessary to exactly neutralize 1 c.c. of Black-leaf "40," follows:—

[6]Dickerson, J. K. Some Chemical Problems of the Insecticide Industry. Jour. Ind. and Eng. Chem., V. 16, No. 10, pp. 1013–1015, Oct., 1924.

[7]Chapin, R. M. The Determination of Nicotine in Nicotine Solutions and Tobacco Extract. U. S. D. A., Bur. An. Ind. Bull. 133, Apr., 1911.

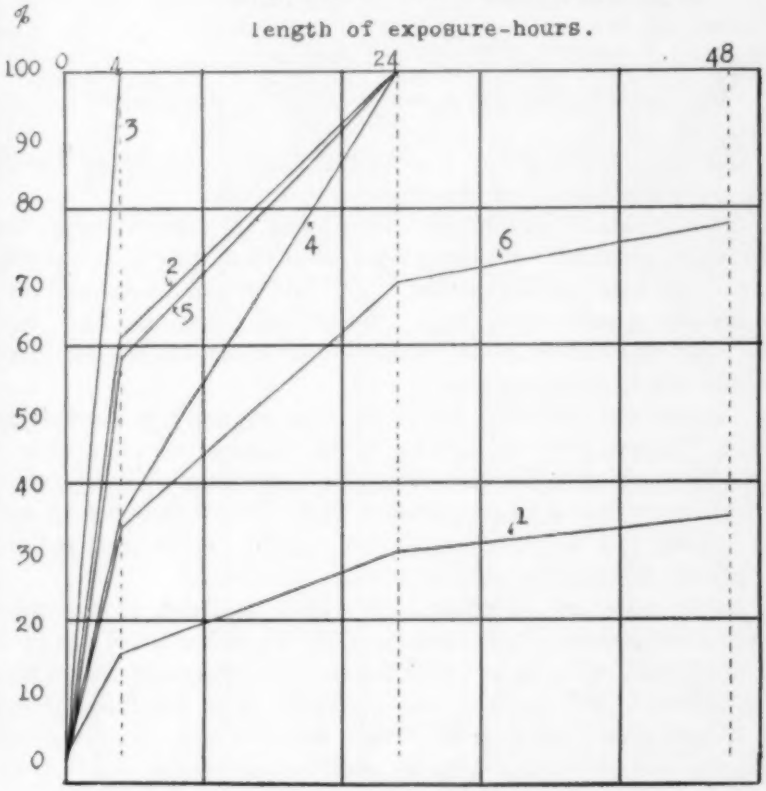
[8]Acknowledgment is gratefully made of the kindness of the Departments of Chemistry and Microbiology, of the Massachusetts Agricultural College. Equipment for the work was willingly placed at the writer's disposal, and the members of these departments unfailingly gratified the frequent desire of the writer to discuss the work.

TABLE 1.—ALKALINITY OF LIBERATORS

Liberator	Amount to neutralize 1 c.c. Black-leaf "40" Indicator brom-thymol-blue Checked by potentiometer
Ammonia	.4 c.c.
Ammonium carbonate	.4 gm.
Sal soda (Arm & Hammer Brand—Crystals)	.34 gm.
Sodium hydroxide	.08 gm.
Gold Dust washing powder	.36 gm.
Ivory Soap flakes	.6 gm.
Good's Caustic Potash Fish-oil soap	1.1 c.c.

The solutions for the gas evolution tests were made up at a strength of 1 part Black-leaf "40" to 100 parts of CO_2 free distilled water, using twice the amount of each liberator necessary to exactly neutralize the

CHART I. EVOLUTION OF NICOTINE FROM SPRAY SOLUTIONS OF BLACK-LEAF "40", 1-100.



Black-leaf "40" present. In addition, the pH of each solution was determined.

In this series of tests, determinations of nicotine were made by washing the exposed plates after 4 hours, 24 hours, and 48 hours. In Table 2, the liberators selected are shown in comparison with a solution of Black-leaf "40" alone, and with sodium hydroxide, which appeared to be the most efficient liberator mentioned by De Ong.[5] Chart I is a graphic representation of the data.

TABLE 2.—EVOLUTION OF NICOTINE FROM SPRAY SOLUTIONS OF BLACK-LEAF "40," 1:100

No.	Liberator Used	Per cent Nicotine Evolved in			pH of Solution
		4 hours	24 Hours	48 Hours	
1	None	15	30	35	3.25
2	Sal soda	61	100		9.17
3	*Sal Soda	100			9.5
4	Sodium hydroxide	35	100		11.75
5	*Sodium hydrox de	58	100		12.17
6	Potash fish-oil soap	34	69	77	7.35

*Liberator at twice the strength of the preceding solution.

The following facts are evident from the above table:

1. The greatest alkalinity is not attended by the greatest evolution of nicotine.

2. Sal soda, while giving a lower alkalinity to the spray solution, is a more efficient liberator than sodium hydroxide.

3. Potash fish-oil soap added to the spray solution causes a slower evolution of nicotine over a longer period of time than from a solution to which sal soda has been added. The rate of evolution, however, is considerably greater than from solutions of Black-leaf "40" alone.

Sal soda and caustic potash fish-oil soap were selected for further study for the following reasons:

1. Among the chemicals tried, sal soda appeared to be the most efficient "liberator" (i. e., throws off the nicotine most rapidly).

2. Under certain conditions it may be more desirable to liberate the nicotine slowly over a longer period of time. Potash fish-oil soap serves this purpose, is a pourable soap mixing readily with water, and gives a beneficial physical character to the spray solution.

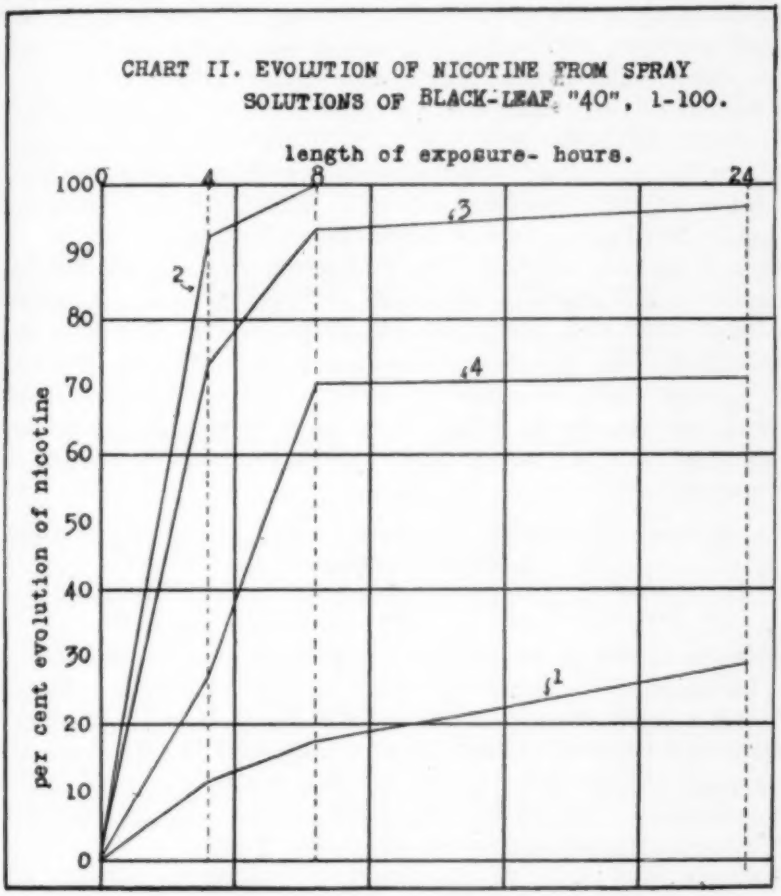
3. Both materials are cheap and readily available to the farmer.

In the subsequent study, solutions of Black-leaf "40" at 1–100 were used, and sal soda at twice the strength necessary to neutralize the Black-leaf "40" present was compared with Bordeaux mixture 4–4–50, and lime sulphur 1–40. These last two materials are alkaline in nature, and are much used in combination sprays with nicotine.

These tests were run in the same room as before, but the temperature was not automatically controlled. It fluctuated between 83°F. and 86.7°F., as recorded by a thermograph. A record of the relative humidity was also obtained. This was very low, and fluctuated between 12 per cent and 26 per cent saturation. A record of this experiment is given in Table 3 and Chart II.

TABLE 3.—EVOLUTION OF NICOTINE FROM SPRAY SOLUTIONS OF BLACK-LEAF "40," 1–100

No.	Liberator used	Per cent Nicotine Evolved in		
		4 Hours	8 Hours	24 Hours
1	None	11.47	17.42	28.78
2.	Sal soda	92.13	100.00	100.00
3.	Bordeaux mixture	73.09	93.50	96.75
4.	Lime sulphur	26.68	70.67	70.84



The following points are to be noted:—

1. The use of Bordeaux mixture and lime-sulphur as carriers of nicotine sulphate in spray solutions, under the conditions of the experiment, caused a rapid evolution of nicotine. While this rate was not quite as rapid as in the case of sal soda, it is quite likely that under field conditions this difference would be less marked.

2. In the case of lime-sulphur, a fairly rapid rate of evolution resulted in a loss of 70.6 per cent of the nicotine in eight hours. After twenty-four hours, only a fraction of 1 per cent additional nicotine had been liberated. Thus nearly 30 per cent of the total nicotine appeared to be bound by the lime-sulphur.

Tests Against Insects

In the spraying tests, twigs laden with aphids were sprayed, using a hand atomizer, and confined, either in cheesecloth covered cages, or on sheets of paper with tanglefooted edges. Counts of the living and dead aphids were made after twenty-four hours, and, in some cases, after shorter and longer periods of time. The percentage killed in each case was figured. Eighty-nine separate sprayings were made during the season of 1924, involving a total of 23,045 aphids. These tests cannot be called extensive, but the results are indicative.

Each experiment called for one twig sprayed with Black-leaf "40" without liberator, one with Black-leaf "40" plus sal soda, and one with Black-leaf "40" plus the potash fish-oil soap. The liberators were employed at twice the amount necessary to neutralize the Black-leaf "40" present. In a few cases the merits of Pyrox and of liquid lime-sulphur were also tested. The species involved were *Myzus persicae*, *Aphis pomi*, and an undetermined species of aphis on spiraea. A summary of results is given in Table 4.

Table 4.—Nicotine Sulphate Versus Aphids. Average—All Tests

% Kill After 24 Hours		
No Liberator	Plus Soda	Plus Soap
78	94	95

With the figures on the evolution of nicotine in mind, the high per cent kill afforded by the use of caustic potash fish-oil soap as a liberator indicates a slight insecticidal action of the soap itself or possibly of liberated fish-oil, even at the reduced dosage used (less than one-fifth the amount recommended by James Good & Company, for aphids).

A comparison between the effectiveness of sal soda as a liberator, and Pyrox and liquid lime-sulphur is given in Table 5.

Pyrox, a ready-made Bordeaux-lead, and liquid lime-sulphur, with

TABLE 5.—BLACK-LEAF "40," 1–1000, AGAINST AN APHID ON BARBERRY

No.	Liberator	% Kill After 6 Hours	% Kill After 24 Hours
1.	None	20	73
2.	Sal soda	52	97
3.	Pyrox	38	93
4.	Soda+Pyrox	58	93
5.	Lime-sulphur (1–40)	39	88
6.	Soda+Lime-sulphur	63	97

CHART III. BLACK-LEAF "40" PLUS LIBERATORS AGAINST Myzus persicae

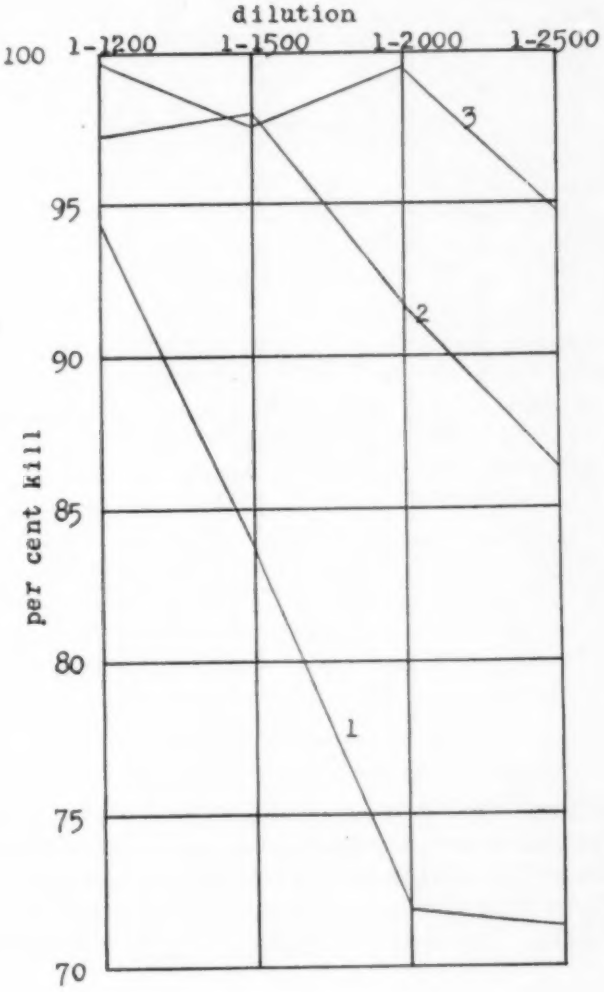
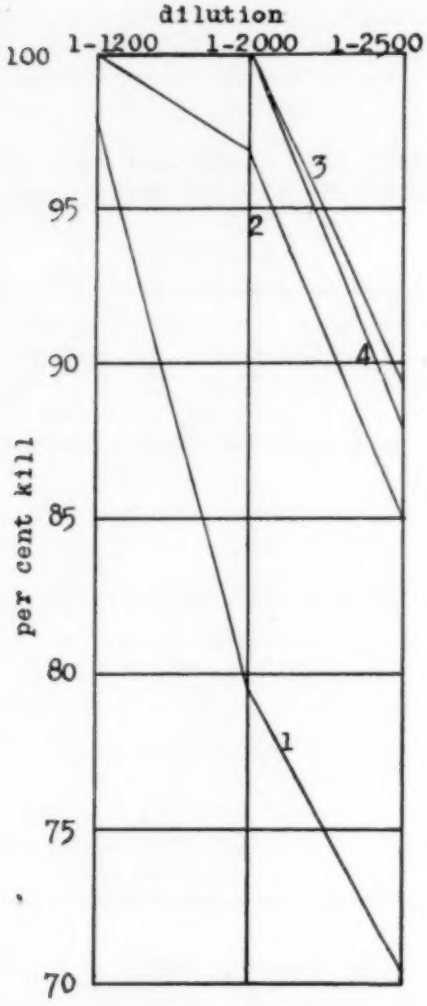


CHART IV. BLACK-LEAF "40" PLUS LIBERATORS AGAINST *Aphis pomi*



which Black-leaf "40" is often combined for spraying purposes, are themselves alkaline, and so increase the rate of evolution of the nicotine. This is indicated by the experiment. It further appears that the addition of sal soda to these combination sprays increases the rate and total per cent of kill. The effect of the sal soda on the effectiveness of the

nicotine-lime-sulphur combination was less marked in the experiments on *Aphis pomi*, as will be shown.

Reduction of Dosage Through Use of Liberators

It is logical to suppose that, if liberators increase the killing power of a solution of nicotine sulphate of given strength, the use of liberators will allow a reduction in dosage of nicotine. To gain information on this point, a series of nicotine sprays was applied at various dilutions. The results are given in Tables 6 and 7, and Charts III and IV.

Table 6.—Black-Leaf "40" Plus Liberators Against *Myzus persicae*

No.	Liberator	% Killed at Dilution of			
		1–1200	1–1500	1–2000	1–2500
1.	None	94.3	83.5	71.9	71.4
2.	Sal soda	97.3	98.0	91.6	86.4
3.	Fish-oil soap	99.7	97.6	99.5	94.7

Table 7.—Black-Leaf "40" Plus Liberators Against *Aphis pomi*

No.	Liberator	% Killed at Dilution of		
		1–1200	1–2000	1–2500
1.	None	98	79.5	70.5
2.	Lime-Sulphur Lead Arsenate	100	96.9	85.0
3.	As in No. 2 plus sal soda	100	100	89.3
4.	Fish-oil soap	100	100	87.9

That the use of liberators will allow a reduction of dosage is plainly indicated. Thus in Graph No. 1, Black-leaf "40" at a dilution of 1–2500 plus potash fish-oil soap gave 95 per cent control, while a dilution of 1–1200 with no liberator gave only 94 per cent control. In Graph No. 2, Black-leaf "40" alone at 1–1200 is little better than Black-leaf "40" 1–2000 plus lime-sulphur, and the addition of sal soda to the regular orchard combination spray appears to make nicotine sulphate perfectly effective against *Aphis pomi* at 1–2000. The possibility of detrimental chemical reactions between the sal soda, the lead arsenate, and the lime-sulphur have not been investigated by the writer. At the rate used in these tests, a 100 gallon tank of Black-leaf "40", 1–1000, requires eight ounces of sal soda, or a pint and a half of potash fish-oil soap.

Application to Squash Vine Borer Control

Further information regarding dosage reduction was obtained in 1924, from field trials of nicotine in dust and spray forms against eggs of the squash vine borer. The writer[9] has shown that Black-leaf "40" at a

[9]Worthley, H. N. The Control of the Squash Vine Borer in Massachusetts. Mass. Agr. Exp. Sta. Bul. 218, Oct., 1923.

dilution of 1 to 200 is effective in this connection. A reduction of dosage requirement was sought. Without going into detail, that portion of the work which is of present interest is here summarized.

NICOTINE AGAINST *Melittia satyriniformis* HBN., AMHERST, MASS., 1924

Treatment	I B. L. "40," 1–250 Alone				III B. L. "40," 1–500 +Soda				IV B. L. "40," 1–500 +Soap			
		Check		Check		Check		Check		Check		Check
Row No.	2	1	9	10	5	4	12	13	8	7	15	16
plants	32	33	45	27	35	29	34	39	38	32	36	34
Plants infested	8	22	17	25	28	25	22	26	18	27	15	32
Per cent infested	25	66	37	92	80	86	64	66	47	84	41	94
No. borers	15	44	25	63	49	66	61	47	25	87	19	93
Borers per plant	.46	1.33	.55	2.33	1.40	2.27	1.79	1.20	.65	2.71	.52	2.73
Per cent infestation treated	34		23		61		149		23		19	
check												
Average Per cent infestation	28				105				21			

Translating the average per cent of infestation to per cent of control, we have:

I. Black-leaf "40", 1–250, alone ..... 73% ± 8% control*
III. Black-leaf "40", 1–500, plus sal soda..... No control
IV. Black-leaf "40", 1–500, plus fish-oil osap. 80% ± 8% control*

The failure of sal soda is attributed to the speed with which the nicotine was thrown off, evidently dissipating it before any could penetrate into the eggs. The striking results with the fish-oil soap, while partly due to the increased evolution of nicotine, are doubtless directly affected by the physical nature of the film of spray which spread, stuck, and dried over the eggs, thus aiding the penetration of the nicotine. A mixture of Black-leaf "40", 1½ pints; potash fish-oil soap, 3 pints; water, 100 gallons, will reduce an infestation of the squash vine borer approximately 80 per cent, using 4 sprays, a week apart in July.

*Probable error figured from the field data.

Conclusion

The work reported in this paper indicates that the use of liberators may allow a reduction in the dosage of nicotine required to kill certain insects. This is accomplished by the increased concentration of nicotine in the atmosphere surrounding the insects occasioned by the more rapid evolution of the nicotine fumes.

Bordeaux mixture and lime-sulphur are good liberators of nicotine, but the efficiency of nicotine in such sprays is increased by the addition of sal soda. With forms easily controlled this may allow a reduction in dosage. It may also aid in reducing such stubborn pests as the rosy apple aphis in curled leaves, and the apple red bugs.

Potash fish-oil soap seems to be the most satisfactory liberator of nicotine when this is used alone, and particularly against resistant forms, such as insect eggs.

For every pint of nicotine sulphate, 12 ounces of sal soda or a quart of fish-oil soap added to the spray mixture will act effectively to increase the efficiency of the nicotine. Potash fish-oil soap gives relatively slow, long continued evolution of nicotine, while sal soda throws it out into the air with great rapidity. As shown in the tests against squash vine borer eggs, this extremely swift evolution of nicotine is not always desirable.

CHEMICAL STUDIES OF THE SULFUR-LIME DRY MIX SPRAY IN REGARD TO THE FORMATION OF WATER SOLUBLE ARSENIC[1]

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Abstract

When Kayso is mixed with acid lead arsenate in absence of both hydrated lime and sulfur, large quantities of soluble arsenic are formed. Still larger quantities of soluble arsenic are released when Kayso is replaced by calcium carbonate. When powdered skimmed milk was substituted for Kayso, a decided reduction in soluble arsenic was found, while no decrease in spreading was observed. The addition of an excess of hydrated lime to the arsenical mixture greatly decreased the amount of soluble arsenic formed but did not entirely eliminate it. Sulfur alone, in absence of Kayso and calcium hydroxide, did not materially influence the decomposition of acid lead arsenate.

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[1] Paper No. 314 of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

INTRODUCTION

Among the several arsenic compounds that have been used as insecticides, the acid lead arsenate ($PbHAsO_4$) remains the outstanding one and is more extensively employed now in orchard sprays than any one of the other arsenicals. Recent investigations have definitely established that this compound, if properly prepared, (13) is comparatively stable and is more toxic to insects (10, 18) than the arsenates of calcium or the basic lead arsenate. Judging from its efficiency as an insecticide and its popularity among agriculturists, it is not an exaggeration to say that this arsenical is, at present, our very best poison for chewing insects which feed on fruit trees, yet it is far from being the ideal one sought for. While it is only slightly soluble in distilled water, chlorides, carbonates, (5, 7) and soluble bases (2), when present in such quantities as may be frequently found in spring or in well waters, are sufficient to decompose it and to liberate arsenic acid or soluble arsenic salts, often in sufficient quantities to cause foliage injury.

It must be recalled here that lead is a weak base and any one of the stronger bases, such as potassium, sodium, or even calcium, when present in soluble form, will readily replace it and combine with the arsenate radical to form soluble salts. Hence $PbHAsO_4$ cannot safely be used in spray mixtures containing soluble soaps (14) or oils emulsified by the aid of soaps.

Furthermore, acid lead arsenate cannot be applied alone on fruit trees in concentrations sufficient to kill insects, without causing injury to foliage, unless some "corrective" such as lime is added. Evidently the $PbHAsO_4$ decomposes when spread on the leaf surface, a process in which the leaf exudates (15) may play an important role, especially if rich in alkalies (16). Lime has been universally used as a corrective since its introduction by Gillette (4) both in dust and liquid mixtures. Hydrated lime is, at present, being used in the sulfur lime dry-mix spray (3) which consists of eight pounds of sulfur, four pounds of hydrated lime, half a pound of Kayso (casein+lime) diluted to fifty gallons of water to which one or 1½ pounds of powered lead arsenate is added. This mixture offers an ideal spray since it serves as a combined insecticide and fungicide and is easily handled. Frequently, however, appreciable burning occurs on peach and apple trees, especially the former, when this spray is used. Haenseler and Martin (6) at this Station have definitely traced the cause of the injury to the lead arsenate.

That arsenical injury to foliage may be, with certainty, ascribed to the water soluble arsenic originally present in the spray or subsequently

formed on the leaf surface has been definitely shown (1, 9, 16, 17) by several investigators. Results from more recent experiments (5, 11) indicate that the calcium carbonate formed when the $Ca(OH)_2$ is exposed to the atmosphere releases water soluble arsenic. The exact chemical role, however, that each one of the three ingredients present in this spray plays in the process of decomposing the lead arsenate has not been definitely established. It is obvious that a better understanding of the reactions involved should offer a means of detecting and possibly of controlling the factors which liberate water soluble arsenic in this spray mixture.

The following investigation was, therefore, carried out with the purpose of studying the influence of each one of the three ingredients namely, hydrated lime, sulfur, and Kayso on the formation of water soluble arsenic from the acid lead arsenate in the sulfur, lime, dry-mix spray.

Experimental

Samples of lead arsenate were mixed with weighed quantities of hydrated lime, sulfur, and Kayso separately; hydrated lime and sulfur; hydrated lime and Kayso; sulfur and Kayso; and finally with all the three ingredients in proportions corresponding to the complete spray. These combinations gave eight different mixtures, including lead arsenate alone used as check. The materials were weighed separately into glass bottles, thoroughly mixed, and 100 c.c. distilled water, previously freed from CO_2, added. The mixtures were kept at room temperature for six days, with frequent shaking, and then diluted to 500 c.c. with distilled water and allowed to stand over night. At the end of this period water soluble arsenic was determined by the Official Methods (12) and calculated as As_2O_5, the percentages being based only on the amount of $PbHAsO_4$ present in the mixtures. The quantities of the different ingredients were equal to those present in 100 c.c. of spray when 1½ pounds of lead-arsenate are used.

A comparison of the data from the chemical analyses shows that hydrated lime reduced the per cent of water soluble arsenic from 2.63 found in the check to 0.91 when added alone to the lead-arsenate and to 0.58 when added mixed with sulfur. On the other hand, the presence of "Kayso" released more than twice the amount of soluble As_2O_5(6.79%) found in the check. Similar increases in soluble arsenic were also observed in mixture 7, where both "Kayso" and sulfur were added. Sulfur in itself, however, has not appreciably affected the decomposition of $PbHAsO_4$ as may be seen from mixture No.3. The fact that Kayso liberated large quantities of soluble As_2O_5 was rather surprising at first, but upon

TABLE 1.—WATER SOLUBLE ARSENIC OBTAINED FROM ACID LEAD ARSENATE WHEN MIXED WITH HYDRATED LIME, KAYSO, AND SULFUR AND KEPT FOR SIX DAYS AT ROOM TEMPERATURE

Mixture No.	Composition	As_2O_5% Series 1	Series 2	Average
1 (Check)	$PbHAsO_4$	2.45	2.80	2.63
2	$PbHAsO_4$, $Ca(OH)_2$	0.74	1.07	0.91
3	$PbHAsO_4$, Sulfur	2.67	2.88	2.72
4	$PbHAsO_4$, Kayso	6.43	7.15	6.79
5	$PbHAsO_4$, $Ca(OH)_2$, Sulfur	0.49	0.66	0.58
6	$PbHAsO_4$, $Ca(OH)_2$, Kayso	0.91	0.83	0.87
7	$PbHAsO_4$, Sulfur, Kayso	6.67	8.25	7.46
8	$PbHAsO_4$, $Ca(OH)_2$, Sulfur, Kayso (Complete Sulfur-lime dry-mix Spray)	0.57	0.78	0.67

further testing it was found to contain considerable quantities of calcium carbonate. It was, therefore, suspected that the $CaCO_3$ was responsible for the above reaction. This assumption was beautifully confirmed by the following experiment, the results of which are presented in Table 2. Several 100 c.c. mixtures were prepared and submitted to the same treatment as described above, with the exception that Kayso was replaced by equal amounts of one of the following:—calcium carbonate, powdered skimmed milk, or casein.

TABLE 2.—WATER SOLUBLE ARSENIC OBTAINED FROM ACID LEAD ARSENATE MIXED WITH CALCIUM CARBONATE, SKIM MILK, CASEIN AND KEPT FOR SIX DAYS AT ROOM TEMPERATURE

Mixture No.	Composition	As_2O_5% 1	1	Average
9 (Check)	$PbHAsO_4$	2.12	2.29	2.20
10	$PbHAsO_4$, $CaCO_3$, Sulfur	7.17	9.32	8.25
11	$PbHAsO_4$, Skim Milk	1.20	1.05	1.13
12	$PbHAsO_4$, Casein	1.20	1.11	1.16
13	$PbHAsO_4$, Sulfur, Skim Milk	1.20	1.32	1.26
14	$PbHAsO_4$, Sulfur, Casein	1.27	1.27	1.27

The per cent of water soluble arsenic from mixture 10, where $CaCO_3$ was used was still greater than that obtained in the presence of Kayso (mixture 4 and 7). On the other hand, wherever Kayso was replaced by either powdered skimmed milk or casein the per cent of soluble As_2O_5 was even considerably smaller than that found in the check. These results are significant and suggest that skimmed milk could be used more advantageously as a spreader. That skimmed milk prevents the forma-

tion of water soluble arsenic from acid lead arsenate has been also observed by Thatcher and Streeter (19) in their Chemical Studies of the Lime Sulfur Spray. Furthermore, the spreading properties of skimmed milk were found by T. J. Headlee (8) to equal those of Kayso. In addition to the above facts it should be mentioned here that powdered skimmed milk is considerably cheaper than Kayso.

The data in Table 1 further show that while four pounds of hydrated lime decrease considerably the amount of soluble arsenic, they do not entirely eliminate it since 0.65% of As_2O_5 was still found in mixture No. 8. In view of this fact it became of interest to determine the proportion of hydrated lime necessary to take up all the soluble arsenic that may be liberated from the acid lead arsenate present in this spray. Accordingly 100 c.c. samples were prepared in which the sulfur, "Kayso" and lead arsenate were in the same proportions as those present in the sulfur lime dry-mix, while the amount of hydrated lime was varied from 0.25 pound to 10 pounds equivalents in fifty gallons of spray. The mixtures were submitted to the same treatment as in the previous experiments and the water soluble arsenic determined at the end of six days.

TABLE 3.—WATER SOLUBLE ARSENIC OBTAINED FROM SULFUR-LIME DRY-MIX SPRAY CONTAINING VARYING CONCENTRATIONS OF HYDRATED LIME KEPT FOR SIX DAYS AT ROOM TEMPERATURE

Mixture No.	Composition	As_2O_5 1	2	Average
15	$PbHAsO_4$	2.43	1.96	2.19
16	$PbHAsO_4$, Sulfur, Kayso, No $Ca(OH)_2$	5.67	4.75	5.21
17	" " " 0.25 lb. "	5.10	4.46	4.78
18	" " " 1 lb. "	1.40	1.20	1.30
19	" " " 2 lb. "	0.90	0.76	0.83
20	" " " 4 lb. "	0.56	0.58	0.57
21	" " " 6 lb. "	0.57	0.43	0.50
22	" " " 8 lb. "	0.41	0.41	0.41
23	" " " 10 lb. "	0.34	0.48	0.41

The results of duplicate analyses presented in Table 3 show again that the highest amount of water soluble arsenic is formed in the spray mixture where no $Ca(OH)_2$ is present. The As_2O_5 gradually decreases with increasing increments of $Ca(OH)_2$, reaching its minimum (0.41%) where hydrated lime equivalent to 8 pounds was used. Higher increases of hydrated lime did not produce any further decreases in the As_2O_5 as may be seen from mixture No. 23, where ten pounds of $Ca(OH)_2$ was applied. These results proved definitely that hydrated lime decreases the amount of soluble arsenic but does not entirely eliminate it. Furthermore, when sprayed on foliage still higher quantities of soluble

As_2O_5 may be expected because, by spreading the spray in thin layers on large surfaces, under atmospheric conditions, a considerable part of the $Ca(OH)_2$ may become carbonated and liberate enough soluble arsenic to cause foliage injury.

In conclusion the author takes this opportunity to express his indebtedness to Dr. T. J. Headlee for valuable suggestions freely given throughout the experiment.

Summary

Chemical investigations of the sulfur lime dry mix spray were carried out with the purpose of studying the reactions involved in the formation of water soluble arsenic. Twenty-three 100 c.c. mixtures of spray were prepared, each one of which contained an equal quantity of acid lead-arsenate but varied in its composition and concentration of the other three ingredients ($Ca(OH)_2$, Sulfur, Kayso). All mixtures were kept at room temperature for six days and the water soluble arsenic determined. The results from these experiments indicate that:

1. Sulfur alone in absence of both Kayso and $Ca(OH)_2$ does not appreciably influence the decomposition of acid lead arsenate.
2. When Kayso is added to $PbHAsO_4$ in absence of $Ca(OH)_2$ large quantities of soluble As_2O_5 are formed. This is apparently brought about by the lime of the Kayso which becomes partially carbonated, upon standing. This phenomenon was not observed when either casein or skim milk was substituted for Kayso.
3. Calcium carbonate in solution reacts directly with the lead arsenate, forming soluble arsenic salts.
4. The presence of an excess of hydrated lime greatly retards the formation of soluble arsenic but does not entirely eliminate it.
5. The smallest quantity of soluble arsenic was found when six or eight pounds of hydrated lime were used in fifty gallons of spray.
6. Sulfur lime dry mix spray could be made more stable chemically by substituting powdered skimmed milk for Kayso.

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A meeting was held in Michigan on June 23, 24, and 25, for the purpose of discussing and studying the virus diseases of the raspberry with the object of familiarizing inspectors with the appearance of diseased plants and with methods to be employed in controlling the various diseases. Representatives were in attendance from the Department of Agriculture and from Ontario, New York, Ohio, Indiana, Illinois, Wisconsin, Minnesota, and Michigan. In the case of some of the states mentioned, the entire corps of nursery inspectors was present. During the course of the meeting many infected plantings were visited in the four southwestern counties of Michigan, and the effect of roguing in controlling the diseases was observed. At the evening meeting, held in the Vincent Hotel at Benton Harbor, on June 24, addresses were made by several men from the Department of Agriculture, and from the state experiment stations.

THE PENETRATION OF A CONTACT OIL SPRAY INTO THE BREATHING SYSTEM OF AN INSECT[1]

By FRANKLIN C. NELSON, M.S., *Crop Protection Institute Fellow, New Brunswick, N. J.*

It has been generally known that sprays such as Nicotine Sulphate or Pyrethrum extract accomplished their results by the volatilized gas entering the breathing system of an insect and attacking the nervous system, causing a gradual paralysis followed by death.

Shafer, Geo. D., (1) colored kerosene with Sudan III and thoroughly sprayed or dipped grasshoppers (*Melanoplus femoratus* Burm.) tomato worms and aphis into the oil. After dissecting these insects, he found more or less of the red oil in the larger tracheae but none in the smaller branches of the breathing system. Tests with kerosene emulsion and the emulsions of the miscible oils colored with indigo-carmine and with safranin gave similar results.

Dewitz, J., (2) in discussing contact insecticides, does not believe that either liquids or powders can enter the spiracles in sufficiently large quantities to cause the death of the insects by suffocation.

McIndoo, N. E., (3) in his work with nicotine sprays and colored water, found that they did not penetrate the spiracles. He says, "Since it has been shown that spray solutions, as applied under practical conditions, do not pass into the tracheae, a study of the spiracles of the aphis, coccids, and larvae that have been used in the experiment shows that it is practically impossible for aqueous solutions to enter the spiracles. The mouths of the spiracles of all these insects except the coccids, are guarded by pseudohairs, which are outgrowths from the chitinous linings of the spiracles and by the rims turning inward and sometimes downward. The spiracles of the coccids are practically unprotected while those of aphids bear a few hairs. The small size of these spiracles seems to be the best reason why aqueous solutions cannot readily pass into the tracheae."

These investigations seem to prove that the volatile gas, then, is all that penetrates the breathing system. Work carried on with "Flit" a commercial insecticide from the Standard Oil Co. of New Jersey, led the author to believe that more than the gas penetrated the breathing system. Bees (*Apis mellifica*) and flies, (*Muscina stabulans* and

[1]This paper is a partial report resulting from an investigation of the properties of Flit, conducted by the Crop Protection Institute and financed by the Standard Oil Company (New Jersey). The work was carried out in cooperation with the New Jersey Agricultural Experiment Station, and under the immediate direction of Dr. T. J. Headlee.

Stomoxys calcitrans), when sprayed, were overcome and killed in a few minutes, but when placed in a bell jar filled with the spray as a gas, the bees did not die in less than 4 to 5 hours and the flies from 2 to 3 hours. This test was repeated ten times with a minimum of ten bees or flies in each test and the results were constant. Tests were then made by spraying equal volumes of "Flit" into tightly stoppered bell jars. In one, the insects in cages, were lowered into the jar while the spray was floating in the air in fine particles. The other jar was allowed to stand twelve hours so that only a gas would be present. Ten runs were made and the bees in the vapor died at least two hours sooner than those in gas only.

"Flit" was colored with National Oil-Red O dye and sprayed on meal worms (*Tenebrio molitor*). These were semi-transparent and the movement of the liquid in the breathing system, could be watched without dissection. The colored spray entered the spiracles, when open, and moved on up into the smaller branches of the tracheae. The spray did not enter where the spiracle was closed, but as soon as the insect became overcome, the liquid covering the spiracular opening, passed thru it. Dissections of sprayed larvae showed red spray present in the very minute branches, a few minutes after spraying.

Direct Spray

The work was then carried on with adult honey bees. Ten bees were sprayed with 1.2 c.c. of colored Flit until a thin film wet the body, and immediate dissections were made. In almost every case examined, the large tracheae and air sacs contained liquid spray or color. In a few cases, the spray was located in a minute tube immediately after spraying. Observations on a few of these bees showed the movement of the liquid spray up into the smaller tubes. In some, the movement was rather fast and in others slow and jerky, the rapidity presumably dependent upon the volume of gas present in the tracheal tubes and its removal either by absorption into the liquid or escape past the liquid and out of the spiracles.

Other lots of bees were sprayed and not dissected for twelve hours. Both ventral and dorsal dissections of the abdomen showed liquid spray in a large number of the minute branches of the tracheae surrounding the digestive tract and nervous system.

Twelve bees were then dipped into liquid "Flit" for 30 seconds. They died at once and an immediate examination showed colored liquid throughout the breathing system, not only in the large tubes, but also in the minute branches leading into the various body systems.

Air Float

Thirty bees, in lots of ten each, were treated with air float instead of direct spray. They were caged to prevent them from getting into any liquid spray on the sides or bottom of the bell jar. As soon as partially overcome, 10–15 minutes, they were removed and examined. The outer surface of the bees was coated with liquid. The air-sacs showed a distinct red color but no spray was seen in the smaller branches of the breathing system.

Other lots of bees were left in the jars five hours before examination was made. These showed a coloring of the air-sacs and many small branches contained red liquid. It apparently took a little time for the smaller branches to be filled with liquid.

One lot of ten bees was treated as above but left in the jars twenty hours. Examination showed liquid in the very smallest tracheal branches. The nerve ganglia were colored but the connectives were not. This coloring of the ganglia does not occur under one hour as other tests showed but the minute breathing tubes do contain color in one hour. A four hour test did not show color in the ganglia. Fifteen hour treatments in air float gave colored ganglia, muscle tissue and some of the Malphigian tubes also showed color. The minute tubes entering the ganglia contained liquid which probably diffused through the nerve cells as they were killed and thus colored the ganglia. It was not determined whether the muscles and Malphigian tubes were colored in this manner but no free color was seen in the body fluids outside the tracheal tubes and it is very probable that the spray entered them through the tubes.

Kerosene Treatment

A repetition of the above series of tests was made with kerosene colored with the same dye. With the exception of the rate and percentage of killing, no difference in results was seen. They died much slower and usually only about 60% were killed with the same volume of spray that killed 100% with "Flit." This showed that the mere blocking of the spiracles or tracheal tubes was not responsible for any great degree of the kill, but the active agent in "Flit" was brought in closer contact and in greater concentration in the breathing system and thus caused a rapid kill.

Dye Carrier

The possibility of the dye leaving the spray liquid and penetrating through the chitinous layer of the tracheae and passing from cell to cell in the epithelium, needed to be settled. Before spraying, the air

tubes were empty and after spraying, it could easily be seen that they contained a red colored liquid which could be made to flow either forward or backward in the tube by means of pressure. The color in tubes through which the spray had passed did not show an even flush of color as would probably have been true if the cells had been dyed instead of a finely divided deposit on the chitinous layer. Dry powdered dye was introduced into the abdominal cavity of several bees and left for twenty-four hours. Examination showed only an exceptional trace of dissolved dye. Powdered dye and honey mixed together was fed to twelve live bees. Examination after twenty-four hours showed dissolved color throughout the digestive tract as well as the honey stomach, but the color was more of a brownish red than a deep pink red, as was secured when the dye was dissolved in kerosene. Most of the dye remained in its original form in the large and small intestines. The dye that did dissolve probably came into contact with fat bodies as it is an oil soluble dye.

None of the dye dissolved in the mixture of honey nor in a water solution.

The final test, however, was to remove several pieces of tracheae containing colored liquid, washed thoroughly to remove any adhering fat or oil and then dipped in a small dish of distilled water and the liquid then squeezed out of the tube. In every case, a distinct colored film of oil formed on the surface of the water, showing that the red color was being carried both by the insecticide "Flit" and by the kerosene check spray and not passing from cell to cell.

Conclusion

From the above results, it may readily be seen that with a spray of kerosene or the insecticide "Flit," a greater penetration of the liquid into the tracheal tubes takes place, than is usually supposed. Undoubtedly, the surface tension of the spray is directly responsible for this penetration and might easily increase or decrease the efficiency of a spray by causing a greater or lesser penetration and thus reduce the concentration of the toxic principle in near proximity to the nervous system.

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ETHYLENE DICHLORIDE-CARBON TETRACHLORIDE MIXTURE; A NEW NON-BURNABLE, NON-EXPLOSIVE FUMIGANT

By R. T. COTTON, *Entomologist, Bureau of Entomology*, and R. C. ROARK, *Associate Chemist, Bureau of Chemistry, U. S. Department of Agriculture.*

ABSTRACT

A new fumigant consisting of 3 parts by volume of ethylene dichloride and 1 part by volume of carbon tetrachloride is very effective against stored product pests. It is cheap, non-inflammable, non-explosive, non-injurious to stored commodities and is not dangerous to human life. It is about five times as toxic as carbon tetrachloride.

INTRODUCTION

During the course of a systematic search for new, effective, and non-hazardous fumigants, a number of aliphatic compounds have been tested that appear to be of considerable value. In view of the urgent need of such fumigants it seems desirable to publish from time to time preliminary accounts of promising compounds without waiting for the completion of the investigation. Information regarding ethylene dichloride is presented at this time.

HISTORICAL

Ethylene dichloride has been tested in regard to its anaesthetic action, its action on yeast cells, white mice, blood vessels, etc., but has never been tested as an insecticide except by the writers and their associates. In a previous publication[1] a report was given regarding tests with ethylene dichloride in bell jars only. These preliminary tests were not very favorable and no large-scale tests were made at that time.

PHYSICAL AND CHEMICAL PROPERTIES OF ETHYLENE DICHLORIDE

Ethylene dichloride is also called ethylene chloride, but its correct designation is s-(meaning symmetrical) dichloroethane, or 1, 2-dichloroethane. In German it is known as alpha, beta-dichloräthan, äthylendichlorid, and äthylenchlorid. In the older chemical literature ethylene dichloride is called elayl chloride and the "oil of the Dutch chemists."

Its empirical formula is $C_2H_4Cl_2$, and its structural formula is CH_2Cl–CH_2Cl, also written as $(CH_2Cl)_2$.

Ethylene dichloride is a colorless liquid with an odor like chloroform. It is about 1¼ times as heavy as water; one gallon of ethylene di-

[1]Neifert, I. E., Cook, F. C., Roark, R. C., Tonkin, W. H., Back, E. A. and Cotton, R. T. Fumigation Against Grain Weevils With Various Volatile Compounds. U. S. D. A. Bull. No. 1313, p. 5, 1925.

chloride at 60°F. weighs 10.4 pounds. Its vapor is over 3 times as heavy as air, which enables it readily to displace the latter if applied from above and penetrate upholstery, rugs, clothing, merchandise, etc., and reach the insects inside.

From the vapor pressure and molecular weight of ethylene dichloride it may be calculated that a room of 1,000 cubic feet capacity will hold 20.5 pounds of ethylene dichloride vapor at a temperature of 20°C. If more than 20.5 pounds of the fumigant are added to a room of this size, the excess will remain as a liquid and will not evaporate. At higher temperatures an increased amount of ethylene dichloride will evaporate, and at a lower temperature a smaller amount.

Ethylene dichloride boils at 83.7°C. and freezes at —36°C. It is only very slightly soluble in water; 100 grams of water at 20°C. dissolve 0.869 gram of ethylene dichloride.

Cost of Fumigant

Ethylene dichloride is made by passing ethylene gas into liquid chlorine at a low temperature. Both of the materials from which it is made are cheap and are commercially available in large quantities. In "Chemical Markets" for June 9, 1927, ethylene dichloride in 50-gallon drums is quoted at 11 cents per pound, and in tank cars at 6 cents per pound, f.o.b. This price is about the same as that of carbon tetrachloride which in the same journal is quoted in 1400-pound drums at 7 to 7½ cents per pound, delivered, and in drums in car lots at 6¾ cents per pound, delivered.

Inflammability

When ethylene dichloride is ignited by a lighted match, it will continue to burn, but only with difficulty. It is on the border line between the fire-extinguising chlorinated hydrocarbons and the combustible hydrocarbons. In order to make it perfectly free from fire hazard when used as a fumigant, it is necessary to add 1 volume of carbon tetrachloride to 3 volumes of ethylene dichloride. This mixture will not burn, and in fact can be used as a fire extinguisher.

Ethylene dichloride and carbon tetrachloride mix readily in all proportions and the mixture has physical properties intermediate between those of its ingredients. Since the boiling points of the two constituents are close, 83.7°C. for ethylene dichloride and 76.8°C. for carbon tetrachloride, the mixture evaporates almost as if it were a single compound.

Effect of Mixture on Various Commodities

The mixture of ethylene dichloride and carbon tetrachloride has no corrosive action on metals nor any bleaching or staining action on textiles of any sort, and when vaporized in a fumigating chamber may be applied freely to rugs, carpets, woolens, linens, mohair, clothing, upholstered furniture, etc., without fear of damage.

Effect Upon Human Life

When the vapor of ethylene dichloride is inhaled it has an anaesthetic action very much like that of chloroform, although less rapid. Unless breathed in high concentrations and for a protracted period of time, no harmful results may be feared in working with this compound.

Insecticidal Action

After extensive experiments in the laboratory had indicated that ethylene dichloride was effective as a fumigant against stored-product insect pests, tests were conducted on a larger scale. For this purpose a standard commercial fumigating vault of 500 cu. ft. capacity was used. It was of very tight construction and adapted to the fumigation

Table 1.—Fumigation Tests with Ethylene Dichloride, Carbon Tetrachloride and Mixture of the Two

Fumigant used	Dosage, lbs. per 1,000 cu. ft.	Length of exposure	Temp.	Per cent killed		
				Anthrenus vorax	*Tineola biselliella*	*Attagenus piceus*
Ethylene dichloride alone	4	24 hrs.	83°F	80	100	90
do	5	24 hrs.	75°F	90	95	90
do	6	24 hrs.	80°F	100	100	100
Ethylene dichloride 3 parts, carbon tetrachloride 1 part by volume	5	48 hrs.	70°F	100	100	100
do	6	24 hrs.	65°F	95	90	80
do	6	24 hrs.	85°F	100	100	100
do	8	24 hrs.	65°F	50	60	85
do	8	24 hrs.	75°F	100	100	100
do	9	24 hrs.	65°F	85	90	100
do	9	24 hrs.	75°F	100	100	100
do	10	24 hrs.	65°F	90	100	100
do	10	24 hrs.	75°F	100	100	100
do	12	24 hrs.	65°F	100	100	100
Carbon tetrachloride alone	25	24 hrs.	75°F	90	90	90
do	30	24 hrs.	85°F	100	100	100

of furniture, rugs, clothing, furs and other commodities. Insects used in the experiments were chiefly, the clothes moth, *Tineola biselliella*, the furniture beetle, *Anthrenus vorax*, and the black carpet beetle, *Attagenus piceus*. In one case other insects were used. The following table contains data regarding the insecticidal action of: ethylene dichloride alone, a mixture of 3 volumes ethylene dichloride and 1 volume carbon tetrachloride and carbon tetrachloride alone, when used at various concentrations, at different temperatures, and with different periods of exposure.

In the above experiments 40 insects of each species were placed in cotton-stoppered, glass vials, and rolled up in rugs, or buried in the stuffing of upholstered furniture. The fumigant was applied by pouring it into a shallow pan near the ceiling of the vault.

Amount of Fumigant Required

The data in Table 1 indicate that 6 lbs. per 1000 cubic feet of space of the 3-to-1 mixture of ethylene dichloride and carbon tetrachloride is 100% lethal when used in a gas-tight vault, with a temperature of 85°F. and a 24-hour exposure. The same dosage at 65°F., however, does not give a perfect kill. A dosage of 12 lbs. of the mixture per 1000 cu. ft. is 100% lethal at temperatures above 65°F. For general fumigation work in gas-tight chambers it is recommended that a dosage of 5 quarts, or 14 lbs. of the mixture per 1000 cu. ft. be used. In comparison with carbon tetrachloride the mixture appears to be about 5 times as toxic at ordinary temperatures.

Powers of Penetration

All experiments with this mixture indicate that the fumigant has excellent powers of penetration. Insects rolled up in thick rugs and buried in overstuffed furniture are readily killed. In a special test, flour beetles, *Tribolium confusum*, and rice weevils, *Sitophilus oryza*, were sealed up in cartons of cereal: specimens of the Indian meal moth, *Plodia interpunctella*, and the saw-tooth grain beetle (*Oryzaephilus surinamensis* were buried in boxes of candy and other insects were buried in piles of clothing and rugs. A dosage of 14 lbs. of the mixture per 1000 cu. ft. at 80°F. gave a perfect kill.

Conclusion

The new mixture appears to be well adapted for general fumigation work in air-tight vaults. It is cheap, has no fire hazard, is non-injurious to furniture or fabrics, is simple to use and is not dangerous to human life when used as recommended.

IMPORTANCE OF PATENT LITERATURE TO ECONOMIC ENTOMOLOGISTS

By R. C. ROARK, *Insecticide and Fungicide Laboratory, Miscellaneous Division, Bureau of Chemistry, Washington, D. C.*

ABSTRACT

The patent literature is of importance to the economic entomologist because: (1) it often describes for the first time a valuable new insecticide; (2) it gives the composition of some proprietary preparations sold under extravagant insecticidal claims; (3) and it describes new apparatus and processes for the application of insecticides and for the destruction of insects by physical means. Paradichlorobenzene, sodium fluoride and chloropicrin were first described as insecticides in the patent literature.

Among the means employed by economic entomologists for the control of injurious insects, the use of insecticides is one of the most valuable. In order to select and apply insecticidal materials to the best advantage, it is necessary not only to know the life history of the insect to be controlled, but also to know what results have been obtained by other workers with the insect in question, or with other insects of similar habits, using various insecticides. Information regarding materials used in destroying or repelling insects or preventing or mitigating their ravages is given in the chemical, pharmaceutical, medical, veterinary, and patent literature, as well as in entomological and agricultural journals. The biological, chemical, and medical literature is abstracted in periodicals issued at regular intervals. The patent literature, however, is never mentioned in any of the medical or biological abstract journals, and the chemical abstract journals contain abstracts only of such patents as relate to the manufacture or use of various chemicals as insecticides. Patents relating to devices for applying insecticides (such as dusters, sprayers, nozzles, and fumigators) and those relating to insect traps and devices for collecting, crushing, cremating, electrocuting, or otherwise physically controlling insects are not abstracted anywhere.

In order to supply this deficiency, the Insecticide and Fungicide Laboratory of the Bureau of Chemistry has started a quarterly review which gives abstracts of the United States patents relating to insecticides and fungicides. This review, in mimeographed form, is sent to anyone requesting it. It is planned to extend this review to include foreign patents.

The value of the patent literature to economic entomologists and others searching for new and better means of insect control may be summarized as follows:

(1) A study of the patent literature frequently brings a valuable new insecticide to the entomologist's attention long before he would become cognizant of it in any other way. For example, the use as insecticides of paradichlorobenzene, sodium fluoride, and chloropicrin was described in patents several years before American economic entomologists became aware of their existence. Paradichlorobenzene was patented in Germany in 1911 (Ger. Pat. 258, 405), and in 1912 in England (British Patent 19,688 (1912); C. A. *8* (1914): 2039) and in 1914 in the United States (U. S. Patent 1,097,406) for use in destroying moths and insects infesting hides, furs, and museum specimens. The first publication by an American entomologist mentioning this compound was that by Duckett (U. S. Dept. Agr. Bull. 167) in 1915. Publication describing its use against the peach tree borer by Blakeslee (U. S. Dept. Agr. Bull. 796) was not made till 1919. Sodium fluoride as an insecticide was described in the patent literature by Higbee (British Patent 8,236 (1896)) in 1896, but it was not until 1915 that an entomological article mentioning this compound appeared in this country (Mich. Agr. Exp. Sta. Tech. Bull. 21). Chloropicrin as an insecticide was patented in 1907 in England by Howorth (British Patent 20,387 (1907)), but ten years elapsed before it was rediscovered by an American entomologist (J. Agr. Research *10* (1917): 365). Is it not reasonable to believe that if abstracts of these patents had been available to American entomologists the present application of these compounds as insecticides would have been worked out many years sooner?

(2) A knowledge of the patent literature is valuable to economic entomologists in protecting the public against worthless proprietary preparations. Many of these are patented and their composition given in the patent literature. Most of them consist of a mixture of materials, the insecticidal value of which is well known. A knowledge of their composition enables the entomologist to form an intelligent opinion of their worth.

(3) Devices for applying insecticides, such as sprayers, dusters, spray nozzles, and fumigating appliances, are constantly being invented. The first information about them is to be obtained from the patent literature. New insect traps, fly swatters, insect barriers, insect attractants and baits, sticky fly paper, and apparatus and processes for destroying insects by crushing, burning, or electrocuting, or by the application of heat, cold, vacuum, or X-rays are first described in the patents issued to their inventors.

APPARATUS AND METHOD USED TO REMOVE PINS FROM INSECT SPECIMENS

By J. E. R. HOLBROOK, *Bureau of Entomology, Melrose Highlands, Mass.*

It is often desirable, and sometimes necessary, to remove pins from mounted insect specimens. This is a tedious operation, and valuable specimens are apt to be injured in the process, especially when they have been pinned for a long time.

A simple method for removing pins from museum specimens has been devised at the gipsy moth laboratory at Melrose Highlands, Mass. This method is so satisfactory that its use would be more general were the method known. It consists of heating the pin by allowing a low

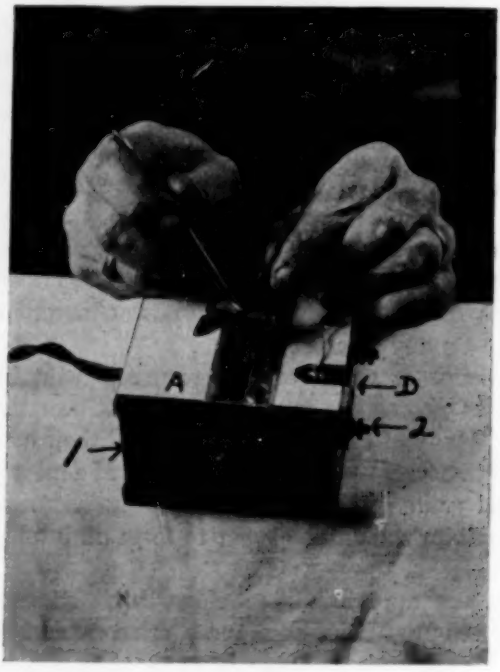

FIG. 24.—Apparatus for removing pins from mounted insect specimens

voltage of electricity to run through it and at the same time of gently pushing the specimen down with a small pair of forceps, as illustrated in the accompanying figure.

A small "step down" transformer, such as is used for operating

mechanical toys, regulates the voltage. The transformer used at the gipsy moth laboratory is constructed so that voltages ranging from 3 volts to 25 volts can be obtained. A current of 3 volts is passed through the pin which is to be removed. A sheet of pressed cork (A) is placed on the top of the transformer and several pieces of tin or lead foil (B) pressed together are fastened to the cork. A thin piece of brass sheeting bent to form a right angle (C) is attached to binding post No. 1 so as to press firmly on the foil. A second piece of brass sheeting (D) is attached to binding post No. 2. It is bent the same as the previous piece, but the top of it rests on the cork, and on its upper surface is soldered a short piece of No. 18 gauge insulated copper wire.

The pin which is to be removed is stuck through the foil into the cork, as shown in the illustration, and the current turned on. The operator connects the free end of the No. 18 gauge wire to the head of the pin and at the same time, with a pair of forceps, gently presses on top of the specimen. Very quickly the pin becomes heated and the gentle pressure on the specimen moves it down to the bottom of the pin, where it is removed without injury. If the pin has been covered with a "finish" a better contact is made by slightly scraping the point and head with a knife or small file before placing it in position for removal. The contact should not be held longer than is necessary for the removal of the insect as the pin will become red hot and scorch it. An operator will quickly acquire this technique and find that pins can be easily removed by this method without injury to the specimens.

In the absence of the electrical equipment described above, a satisfactory arrangement may be made by the use of two 1½ volt dry batteries. These may be connected either in series or in parallel. The pressed cork and foil are prepared as in the previous case. No. 18 gauge wire is used and one wire from the batteries is attached to the foil and the other is brought in contact with the pin that is to be removed.

Scientific Notes

Concerning Oviposition of the Codling Moth: The winter of 1925-26 in the Yucaipa-Beaumont district in California was unusually mild. This fact probably along with other conditions resulted in many unharvested apples hanging on the trees throughout the winter and until June and July of the following summer. In case of about one hundred trees of the Winter Banana variety, which were under especial observation, the apples were scarcely shrivelled at all and gave forth a rich apple odor during most of the period when the moths of the first brood were active. It was thought probable that the moths would lay many eggs on the old apples

especially during the early part of the season when the apples of the new crop were small. On the contrary, however, frequent inspections were made but not a single egg was found on any of the old apples. Neither did there seem to be any tendency for the moths to lay eggs on the leaves near these apples.

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Biological Control of the Codling Moth (*Carpocapsa pomonella.*) The initial experiment carried on this spring by the Saticoy Walnut Growers Association in controlling the codling moth by means of its natural parasite, *Trichogramma minutum*, indicates that biological control of this pest may be a commercial success.

Thousands of the parasites are being liberated at the centers of infestation. A high percentage of codling moth eggs are found to be parasitised within two weeks after the liberation. Normal egg-parasitism is so light that it does not interfere in determining the effect of the liberations. On a large walnut tree parasites were observed stinging the moth eggs on the side opposite the point of liberation. Two parasites were found on a single egg.

Experimental work started in August 1926 with ten females reared from tortrix eggs. Using the Angoumois grain moth as host in the rearing room a daily production of two hundred thousand *Trichogramma* has been attained. The egg production of the moths obtained from a ton and a half of infested Indian corn amounts to about three hundred thousand eggs daily. The original bin of corn infested during the summer of 1926 is still producing moths in abundance.

A rapid reproduction of *Trichogramma* is obtained at a uniform temperature of about 83 degrees. At this temperature its life-cycle is eight days.

A daily production of a million parasites is the goal set for the Association Insectary. A limited amount of *Trichogramma* in the pupal stage are available for distribution at the rate of 10c per thousand in quantities of not less than 10,000.

STANLEY E. FLANDERS

A Note Regarding the Distribution of the Alfalfa Weevil. Since the publication of my paper (Jour. Agr. Res. 30:479, 1925) on this subject, I have, on various occasions, noted some confusion regarding the findings in that paper. An example is the comment of Newton (Jour. Econ. Ent. 19:371, 1926) that the infestation in eastern Wyoming upsets those conclusions. On page 479 of my paper, I stated that the work was an attempt to determine the "probable economic distribution" of the species, but neglected to define this term. The intention was to distinguish the *economic* distribution, or area of damage, from the *systematic* distribution, within which specimens may be captured. I did not intend, by any means, to imply that the weevil would not be found outside the zones as there outlined, but I did intend, and still maintain, that it will do no great damage elsewhere.

The recently discovered infestation in eastern Wyoming does not distrub the major premise of my paper. The weevil, although apparently established in this region, has done little or no damage. Corkins (Jour. Econ. Ent. 19:375, 1926) states:

"There are two areas in this territory which show some slight damage this year. However, the growers themselves had never detected it and didn't know that anything was damaging their crop."

This is far from being "economic damage" in the usual sense of the word. Further, if the reader will examine my paper, he will find most of the eastern slope of the Rockies included in the "zone of possible occurrence," defined as a region where the weevil will "probably not maintain itself, but. . .may become of minor importance after a series of favorable seasons." The major climatic factor used to exclude the weevil from the northern Plains is winter temperature, combined with light snowfall. Anyone interested in climatology will find in the Monthly Weather Review for February 1927, p. 81, a note on the remarkable series of mild winters from 1917–18 to 1926–27. These conditions have also enabled many other insects temporarily to extend their ranges.

WILLIAM C. COOK, *University of Minnesota*

An Introduced Cabbage Weevil. On June 22, 1927, specimens of a small weevil were received from Hartsdale, Westchester County, N. Y., which were reported as being injurious to seedling cabbage. Mr. L. L. Buchanan of the U. S. National Museum, Washington, D. C., determined these as *Ceutorhynchus erysimi* Fab. He believes this species has not been definitely recorded from the United States heretofore.

Nearly all of the plants in a small field were destroyed by this weevil. The cabbage was sown in hills thirty inches apart, each way, with five or six seeds in each hill. Injury took place when the plants were one or two inches high. Applications of a dust, arsenate of lead one part, hydrated lime 4 parts, was moderately effective in preventing injury.

Several specimens of *C. erysimi* were found on a mustard plant which grew near the cabbage. In Germany Urban (Ent. Blatter 20:86. 1924) has reared this species from larvae infesting the stems and roots of Shepherd's Purse, *Capsella bursa-pastoris*. Upon reaching maturity in June and July the larvae enter the soil to pupate. The pupal period is two or three weeks. Other workers have taken the adults on cruciferous weeds but no record was found of *C. erysimi* as a pest of cultivated *Cruciferae*. The species is apparently common and widespread in the old world. Schultze (Deutsche Ent. Zeit 1902:205) gives its distribution as Europe, Asia Minor, Algeria and Siberia.

P. J. CHAPMAN, *Cornell University, Ithaca, N. Y.*

Notes on *Eutettix tenella* (Baker) in Northern California, 1927. The overwintering population of *E. tenella* in the San Joaquin foothills, which is the only permanent overwinter breeding ground in northern California, was enormous and a very serious infestation was threatened to all of the beet fields north of the Tehachapai range of mountains. In early March some very heavy downpours occurred in the foothill breeding area south of Coalinga from Coalinga to Maricopa and Bakersfield and destroyed the maximum emergence of E. *tenella*. These hoppers were mostly in the first and second instars. In the latter part of March and early April, a very serious aphis infestation destroyed the bulk of the short filaree in the little Panoche and Tracy areas on which the most of the eggs of *E. tenella* were laid and to some extent this same thing occurred in the area between Coalinga and little Panoche. Altogether about three-fourths of the possible crop of *E. tenella* was destroyed. At the time of the migration of *E. tenella* from the San Joaquin foothills, east winds were blowing, carrying a large number of beet leaf hoppers from the San Joaquin to the

Salinas Valley. As a consequence the Salinas Valley has a serious infestation and the Sacramento Valley, which is an extension of the San Joaquin Valley to the north, has a light infestation. The writer has proved by conclusive research that the *E. tenella* migrate as far as 85 miles in one night and that they make a second flight from the floor of the San Joaquin Valley to the Sacramento Valley. The time of flight from the San Joaquin to the Sacramento Valley has been predicted accurately for two seasons by the writer. In 1926 and also in 1927 there have been three flights from the San Joaquin to the Sacramento Valley. The population in certain portions of the San Joaquin Valley was noticed to increase on certain atriplexes as follows: April 22—4; May 3—18; flight took place on night of May 4; May 1—5; May 9—10; May 12—12; flight took place on night of May 12; May 13—6; May 17—6; June 6—6. No increase in population in the section examined occurred after May 12 on which date the last flight to the Sacramento Valley occurred. On June 6 nymphs were beginning to be abundant. By using this system the writer can determine exactly when it is safe to plant late beets in the Sacramento delta. Flights from the San Joaquin to the Salinas Valley have been predicted each year since 1922 by the writer, but he has not been generally believed until 1927 when all doubt of such flights of *E. tenella* have been removed.

In connection with insect forecasting, the writer noted the presence of enormous numbers of aphis in the San Joaquin foothills in March and predicted a serious outbreak of aphis for April in the San Joaquin Valley. This outbreak occurred. Also the writer warned growers in the Sacramento Valley of the presence of large numbers of aphis on ditchbanks in time to do effective control work. It is the opinion of the writer that this side of economic entomology has been vastly neglected. Mr. Walter Carter of U. S. D. A., at Twin Falls, Idaho, is doing valuable basic work along this line.

E. A. SCHWING, *Entomologist, Spreckels Sugar Co.*

The Argentine Ant an Odorous Species. During the past thirteen years, or since the publiction of Bulletin 122 by the Bureau of Entomology, entitled, "Th Argentina Ant," the opinion has been prevalent that the worker of this species is an odorless ant. This means that when workers are crushed between the fingers the ants, *Iridomyrmex humilis*, give off no perceptible odor. This belief no doubt originated with the publication of the above bulletin, which on page 31 has the following statement concerning this subject, "Argentine workers, when crushed between the fingers give no perceptible odor and this readily distinguishes them from their closest relative, *Iridomyrmex analis*, as well as from their remote relatives, the species of *Tapinoma*."

The writer being able to distinguish this species without crushing the workers readily accepted the statement for years and even went so far as to cite this characteristic as a means of distinguishing the workers of the Argentine ants from those of closely allied species.

Recently, however, he was surprised to detect a very characteristic, somewhat greasy or musty odor about the crushed ants. This was immediately called to the attention of other State Plant Board workers, who readily agreed with the writer as to the presence of the odor and the nature of its smell. Since this discovery Argentine ant workers have been tested out in various sections of the state and in every case the investigator has found the same characteristic odor present.

Whether this odor has been induced by some special food, or whether the workers

could have acquired an odor since the introduction of the species into this country is not known. However, either view seems rather untenable, hence, the writer is led to conclude that the Argentine ant worker does possess a typical musty or greasy odor. M. R. SMITH, *State Plant Board, Agricultural College, Miss.*

Another Poisonous Caterpillar. In June 1925, while on vacation at Castle Dale, Utah, I was told of a poisonous caterpillar which had caused considerable annoyance during the preceding three years. It had been especially troublesome to barefoot children playing in the shade of large boxelder trees, often causing quite painful injuries. I was especially interested in it because from the numerous accounts of my friends it must have been introduced since I had left there in 1916. As I was able to find only pupae these were sent to Washington, D. C., and were determined by Mr. Heinrich as *Apatela americana* Harris, which he said was not poisonous.

In July 1926, while again on vacation in that vicinity, I questioned many people who had been injured by these caterpillars. In some instances the injury had been so severe as to require medical attention. Apparently most every one knew of the poisonous caterpillars and knew them by sight as there had been considerable agitation about cutting down all boxelder trees in order to rid the country of their chief host plant.

I collected a number of the larvae of different sizes and sent them to Washington. They were identified by Messrs. Busck and Heinrich who said that they were certainly not poisonous. However, one of the caterpillars which I sent to them had been taken immediately after crawling across my little girl's bare foot. It caused a distinct welt across her foot, the swelling and dermatitis of which caused considerable pain and annoyance. This seemed to be the typical injury caused as some people said that the caterpillar caused a painful stripe just as if they had been hit with a whip.

Although Mr. Busck and Mr. Heinrich say that this caterpillar is not poisonous, I have the statement of more than a dozen reliable persons who have been injured by it, so that it certainly is poisonous under some conditions.

It is not surprising that it is poisonous as other species in the same genus are known to be poisonous. Paul A. Gilmer, in "A Comparative Study of the Poison Apparatus of Certain Lepidopterous Larvae," Annals of the Ent. Soc. of A., Vol. 18, No. 2, page 203, reports *Apatela populi* Ril. and *A. oblinita* Sm. and Abb. as being poisonous. He says that it is very probable that cases of caterpillar rash are more widely spread than is commonly supposed and it is very probable that many of the so-called "hives" and other summer urticarias are due primarily to caterpillar hairs.

A. O. LARSON, *Alhambra, Calif.*

ENDOWMENT COMMITTEE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

At the last annual meeting the President was authorized to appoint an endowment committee and the undersigned have been asked to serve in that capacity. The work will be taken up and plans formulated so that more information will be available on this subject by the time of the next annual meeting. It is hoped that every member of the Association will cooperate in assisting the committee in this work.

A. F. BURGESS, *Chairman*
J. G. SANDERS
G. A. DEAN

INSECT PESTS OF SUGAR CANE CONSIDERED AT THE HAVANA MEETING OF THE INTERNATIONAL SOCIETY OF SUGAR CANE TECHNOLOGISTS

The Second Triennial Convention of the International Society of Sugar Cane Technologists was held in Havana, Cuba, during the week of March 14th, 1927. The sessions of the convention were divided under six main technical sections, one of which referred to insects of sugar cane. Mr. H. P. Agee, Director of the Hawaiian Sugar Planters' Association Experiment Station, Honolulu, was General Chairman, while Mr. D. L. Van Dine, Local Director of the Cuba Sugar Club Experiment Station, Tropical Plant Research Foundation, was Secretary of the Proceedings.

The following entomologists were present: B. T. Barreto of Cuba, S. C. Bruner of Cuba, W. E. Hinds of Louisiana, T. E. Holloway of Louisiana, H. T. Osborn of Mexico, H. K. Plank of Cuba, A. H. Rosenfeld of Louisiana, C. F. Stahl of Cuba, D. L. Van Dine of Cuba, and C. E. Woolman of Louisiana.

By prearrangement among the entomologists present, the time given to the section on insect pests of sugar cane (including the utilization of parasites) was devoted to a discussion of borers of sugar cane and the general subject of parasite introduction.

The first session on insects was held on Tuesday afternoon, March 15th. The writer was asked to open the subject of sugar cane borers with a talk on the moth borer of Louisiana and elsewhere. The statement of the writer and the discussion which followed covered the damage, the loss, seasonal abundance and measures of control, with mention of the many factors which influence infestation. Those who took part in the discussion were Dr. Jacob Jeswiet of Java, Dr. Ph. Van Harreveld of the Netherlands, Mr. A. H. Rosenfeld of Louisiana, Dr. Julius Matz of Porto Rico, Dr. W. E. Hinds of Louisiana, Mr. W. G. Taggart of Louisiana, Mr. R. Menendez Ramos of Cuba, Mr. F. A. Lopez Dominguez of Porto Rico, Mr. H. P. Agee of Hawaii, Mr. H. H. Storey of South Africa, Mr. H. F. Clarke of Fiji, Mr. H. T. Osborn of Mexico, Mr. W. T. Seymour-Howe of Queensland, Mr. G. M. Fortun of Cuba, Mr. B. T. Barreto of Cuba, Mr. H. K. Plank of Cuba, Mr. S. C. Munson of Louisiana, Mr. C. D. Kemper of Louisiana, Mr. F. S. Earle of Cuba, and Mr. C. E. Woolman of Louisiana.

Under measures of direct control, Dr. W. E. Hinds and Mr. H. K. Plank reported results obtained with various chemicals. Mr. C. E. Woolman showed a motion picture of the application of poison dust to cotton by airplane, and Dr. Hinds showed lantern slides of the application to sugar cane.

The second meeting of the insect session was held on Thursday afternoon, March 17th. Mr. H. P. Agee, of the Hawaiian Sugar Planters' Association Experiment Station told in considerable detail of the many explorations which have been made by the Hawaiian entomologists for parasites of the insect pest of sugar cane. He brought out the fact that three major cane insects have been brought under control by this method. Mr. Agee pointed out that many parasites for pests other than those of sugar cane have also been introduced into Hawaii by the entomologists of the sugar planters' station. He emphasized the persistence with which the work has been carried on, and the fact that after long years of effort, failure or only partial success has been turned into complete success.

In the discussion of the subject of parasites, it was suggested that perhaps Hawaii is especially favorably situated in climate and isolation for the success of work of this character. Mr. Agee stated that much of the work would doubtless have failed if the entomologists had not gone ahead year after year with great confidence in their

work and with equal confidence on the part of the sugar planters back of them. Mr. Van Dine reminded the members that the Hawaiian work was inspired by the success of Mr. Albert Koebele, who very early introduced the natural enemy of the cottony cushion scale into California from Australia, an example of bringing and establishing a beneficial insect from one continental area to another and under climatic conditions less favorable than those of Hawaii.

The discussion then centered around a plan presented by Mr. Rosenfeld for Mr. Harold E. Box of Argentina, who proposed international cooperation in the matter of exploration for parasites of sugar cane insects. This idea was supported by Mr. J. T. Crawley and Dr. Julius Matz. Mr. Van Dine, as chairman of the section on insects, suggested that a committee be proposed to consider the question and that the Society in general session be requested to act. The action of the Society was to accept the idea of such a committee, which was formed with the following members: A. H. Rosenfeld, Louisiana, Chairman,; J. T. Crawley, Cuba; J. Matz, Porto Rico. The special subject for this committee is cooperative exploration for parasites of sugar cane insects.

In the general session it was brought out that a regular standing committee should be appointed for each section, thus providing for a means of compiling and distributing information between conventions. In accordance with the resolutions adopted, the following Committee on Insect Pests of Sugar Cane (Including Biological Control) was appointed: F. Muir, Hawaii, Chairman; T. E. Holloway, Louisiana; Dr. Hazelhoff, Java; Masato Ishida, Formosa; H. T. Osborn, Mexico; D. L. Van Dine, Cuba.

An entomological subject which was on the program of the section on plant pathology was a consideration of the insect transmission of the sugar cane mosaic disease, by Mr. C. F. Stahl, of the Tropical Plant Research Foundation. Mr. Stahl told of his work in Cuba with the corn aphis, the only known vector.

It was the unanimous opinion that the sessions of the convention were of extraordinary interest and value. Besides the meetings, an excursion was provided to Central Hershey, a large sugar factory thirty miles from Havana by electric railroad, and to the Agricultural Experiment Station of the Cuban Government at Santiago de las Vegas.

On Sunday night, March 20th, the visiting members of the Society boarded a special train of Pullman cars provided by the Government, and a week's tour of the island was made as guests of the Republic of Cuba.

A number of the large estates and sugar factories were visited and special examination was made of the work of the Cuba Sugar Club Experiment Station of the Tropical Plant Research Foundation at Centrals Baragua and Jaronu.

At the final session of the convention Java was selected as the next meeting place, the time being in the early fall of 1929. Dr. Jacob Jeswiet of Java was elected General Chairman for the Java meeting and Mr. D. L. Van Dine of Cuba as General Secretary.

T. E. Holloway, *Bureau of Entomology*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1927

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

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The Editor invested a nickel in a popular weekly with a circulation of over two million and six hundred thousand. The cover illustration depicts wonder and very naturally suggests the query: Is there a limit? The most interesting feature to an entomologist is the story of: "The Battle of the European Corn Borer." It is a very successful example of publicity, undoubtedly facilitated by the ten million dollars expended, one fourth for equipment such as 1240 tractors, 800 stubble pulverizers, as many covering plows, 64 field burners, 100 3½ ton trucks, 75 1-ton trucks, 74 stalk-pile burner rigs, 100 busses for scavenging crews, 64 tank trailers for field burners, 15 1000-gallon tank trucks, 50 600-gallon tank trucks, 475 slip-on-body ½ ton trucks and 75 small coupes. It reads like equipment for an army, and it is. The organization was evidently based on methods learned in the World War. The story itself is of more than passing interest. It is intelligible to the man on the street. It brings out the important points. Certain phases may have been somewhat over-stated in the judgment of the cold, calculating scientist. Broadly speaking the facts justify much that was written. It is one of the outstanding examples of publicity in economic entomology and as such entomologists are urged to invest a nickel in the issue of the Saturday Evening Post for July 16, 1927 and study both the cover illustration and the article on the European Corn Borer. The question is bound to arise: Is there a limit? Certainly no entomological bulletin or report as we know such documents would be issued in any such edition. Economic entomology, especially large-

scale control work, has developed enormously—much beyond what many entomologists realize and the end has not been reached. Perplexing questions as to policies are ever present. The recent clean-up of corn borer territory has been a very effective demonstration of mobilization possibilities. The material welfare of the country is dependent to a very considerable extent upon control of insect pests. Quarantines are enforced to prevent spread. The government and states have combined forces for the reduction of a general corn borer infestation. This latter is but an extension of quarantine, and quite possibly a very economical method of restricting spread. It is a new development deserving careful study.

Obituary

RALPH INGRAM SMITH

RALPH INGRAM SMITH was born at Leverett, Massachusetts, September 16, 1882, and died February 26, 1927, at Boston, Massachusetts, as the result of a combined attack of pleurisy and grippe.

He was graduated from the Massachusetts Agricultural College in 1901 and shortly thereafter accepted a position as Assistant Entomologist at the Maryland Agricultural College, serving in that capacity until July 1903. In August of that year, he was appointed Assistant Entomologist to the Georgia State Board of Entomology, and in 1905, was made Entomologist to that Board. In 1907, he was appointed Entomologist to the North Carolina Agricultural and Mechanical College and Experiment Station, and served in that capacity until December 1911. Early in 1912 he was appointed Professor of Entomology at the College of Agriculture and Mechanical Arts, Porto Rico. From 1915, until the time of his death, he was in charge of the activities of the Federal Horticultural Board, United States Department of Agriculture, in the port of Boston. Mr. Smith was the author of a number of publications relating to economic entomology.

He was a member of the American Association for the Advancement of Science, the Entomological Society of America, and the Association of Economic Entomologists.

The experience gained by Mr. Smith in his early entomological work peculiarly fitted him for the position in Boston, which he filled with credit to himself and the Board he represented. He was ever mindful of the necessity of protecting this country from invasion by injurious insects and plant diseases, and during his service in Boston he was

responsible for a number of very important interceptions. Along with his firmness, however, there was a human strain which made it possible for him to see the problem from all angles, which resulted in his having a host of friends among the importers and his associates in other branches of the Government service. He was a man of splendid character, a staunch and loyal friend, devoted to his home and family, and highly appreciated in the community in which he lived. In his untimely death, the Federal Horticultural Board, as well as his associates and co-workers, have suffered a distinct loss.

E. R. S.

Review

Manual of Forest Insects, by H. B. PEIRSON. Main Forest Service, Augusta, Maine. Bulletin No. 5, pp. 1–130, 1927.

This new bulletin by Mr. Peirson supplies the information on forest insects of economic importance which has been greatly needed by the forest worker of New England. The arrangement of subject matter whereby the insects attacking each species of forest tree are listed as a group, is of especial interest and use to the field worker while the lists of "Other Insects," which includes those species sometimes found attacking the forest tree species concerned, will be particularly useful in identifying the unusual cases which are encountered in the forest. It is as a handy manual for field use in the identification of insects and insect injuries by the workers relatively inexpert in Entomology that this bulletin will attain its greatest use, although the arrangement of the bulletin, the attention paid to description, particularly to that of the injury caused by the insect concerned, and the fact that but little has been written on this subject and compiled in a handy volume will make this bulletin one of use to all interested in forest insects.

As intimated by the author in his introduction, the control of forest insects still consists of simple measures and is relatively undeveloped. The lack of specific control recommendations in this, as in practically all bulletins concerned with forest insects, is to be taken as an indication of opportunity for future work and not as a weakness of the bulletin.

This publication is indicative throughout of careful and detailed work and can be extremely useful in spreading a knowledge of the forest insects of economic importanc.

K. A. SALMAN

Current Notes

Mr. A. G. Dustan recently gave a talk on garden insects and their control at the annual banquet of the Ottawa Horticultural Society.

Dr. Roger B. Friend, Assistant Entomologist of the Connecticut Agricultural Experiment Station, received the degree of doctor of philosophy from Yale University on June 22.

R. L. Smith

J. M. Aldrich, of the U. S. National Museum, is collecting Diptera this summer through a half-dozen states west of the Great Plains.

Professor H. C. Fall of Tyngsboro, Mass., visited the Division of Insects, U. S. National Museum from May 24 to May 27, studying types in the Casey Collection of Coleoptera.

Dr. B. A. Porter of Vincennes, Ind., visited the Japanese Beetle Laboratory, Riverton, N. J., on May 26 and conferred with E. R. Van Leeuwen relative to codling moth investigations.

Dr. S. Hadwen, of the University of Saskatchewan, visited Ottawa on May 10 and spent some time discussing matters of entomological interest with the Dominion Entomologist.

The Kansas Entomological Society held a field meeting on July 3 and 4 at the Sand Hills, Medora, Kansas. Many interesting insects were collected on this trip.

According to *Science*, Professor William Morton Wheeler, Dean of Bussey Institution of Harvard University, has been awarded the Dollfus prize of the French Entomological Society.

Mr. Harvey L. Sweetman resigned his assistantship in entomology at the University of Minnesota, April 1, 1927, to accept a position with State Entomologist C. L. Corkins of Wyoming.

Dr. Stanley C. Ball, formerly curator of collections, Bishop Museum, Honolulu, has resigned to accept a position as curator of zoology at Peabody Museum, Yale University.

At the recent commencement of the University of Illinois, the degree of Doctor of Philosophy in Entomology was conferred upon Messrs. M. R. Smith and R. M. DeCoursey.

Mr. M. R. Smith spent several weeks during June obtaining records for the Illinois State Natural History Survey of the Illinois Lepidoptera in the Barnes Collection at Decatur.

An office has been opened at 682 Main Street, Stamford, Conn., for the enforcement of the quarantine against the Japanese beetle, State and Federal forces coöperating.

According to *Science*, Dr. George H. F. Nuttall, Professor of Parasitology in the University of Cambridge, has been made Professor *honoris causa*, in the University of Strasbourg.

According to *Science*, Dr. R. J. Tillyard, Chief of the Biological Department, Cawthron Institute, Nelson, New Zealand, has been elected an honorary member of the Entomological Society of Belgium.

Science reports that the honorary degree of doctor of science has recently been conferred by the University of Pittsburgh upon Hugo Kahl, Curator of Entomology in Carnegie Museum.

Messrs. S. S. Crossman, C. W. Collins, and D. F. Barnes of the Federal gipsy moth forces, visited Albany, New York, in April, where they conferred with Dr. E. P. Felt and Mr. H. L. McIntyre.

Mr. A. F. Burgess gave a fifteen-minute talk on "The Gipsy Moth," as part of the Burgess Radio Nature League program, from the Westinghouse Radio Station WBZ on March 30.

Mr. Herbert L. Parten, a graduate of the University of Minnesota, and at present a graduate student at that institution, has been appointed Extension Entomologist at the University of Minnesota.

President R. W. Harned attended the meetings of the Western Plant Quarantine Board and the Pacific Slope Branch at Reno, Nevada, June 20 to 24, and afterward visited a number of stations in California.

Mr. F. G. Holdaway from Australia, who has been studying at Cornell University, has recently visited several state and Federal entomological laboratories and field stations in the eastern United States.

At the annual meeting of the Entomological Club of Southern California, held in Alhambra, June 17, the following officers were elected: H. J. Ryan, President; George P. Weldon, Vice-President, and C. K. Fisher, Secretary-Treasurer.

According to *Science*, Professor E. W. Stafford, of the Mississippi Agricultural and Mechanical College, will offer the summer work in elementary and advanced entomology at the summer session of the University of Minnesota.

The following transfers in the Bureau of Entomology have been announced: Ralph A. Blanchard, from Monroe, Michigan, to Tempe, Arizona; H. C. Hallock, Riverton, New Jersey, to Westbury, Long Island; Dr. N. E. McIndoo, Washington, D. C., to Sligo, Maryland.

Mr. Edwin H. Bryan Jr., formerly entomologist on the staff of Bishop Museum, Honolulu, has been appointed curator of collections *vice* Dr. Stanley C. Ball, who resigned to accept a similar position at Peabody Museum, Yale University.

According to *Science*, Mr. R. H. Bell, formerly Assistant Director of Agricultural Extension Work at State College, has been appointed Director of the Bureau of Plant Industry, Pennsylvania Department of Agriculture *vice* C. H. Hadley, who resigned May 1.

Dr. C. H. Kennedy, of Ohio State University, visited the Japanese Beetle Laboratory the last week in May. Dr. Kennedy has arranged for the transfer of the Wenzel Collection of Coleoptera from Philadelphia to Columbus, Ohio.

European corn borer parasite importations by the Bureau of Entomology this spring are as follows: 160,970 *Microgaster* cocoons; 33,831 *Eulimneria* cocoons; 1,661,590 corn borer larvae, from which five additional species will be reared at Arlington, Mass.

Mr. T. R. Gardner, who left Riverton, N. J., early in May, has arrived at his station in Yokohama, Japan. He will continue collecting *Popillia* parasites in Japan, in Chosen, and, so far as conditions permit, in China.

Dr. W. P. Hayes, Assistant Professor of Entomology, Illinois University, is with the Department of Entomology, Kansas State Agricultural College, this summer helping with the inspection and certification of flour mills which are exporting flour to Europe.

Mr. S. A. Rohwer has been appointed business manager of the Bureau of Entomology in addition to his duties as head of the Taxonomic Division of the U.S. National Museum. Mr. E. B. O'Leary has been appointed Administrative Assistant.

According to *Science*, Miss Edith W. Mank, Lawrence, Mass., has been awarded a second prize by the Boston Society of Natural History, for a manuscript entitled "The Life History of *Baris scolopacea* Germ." This is one of the Walker prizes.

Dr. J. M. Swaine, Entomological Branch, attended a European corn borer conference at Chatham, Ontario, in the latter part of April, and later proceeded to Amherst, Mass., to attend a conference on the white pine weevil with United States officials.

According to *Science*, the collection of Lepidoptera made many years ago by the late Henry F. Schoenborn of Washington, D. C., has been presented to the U. S. National Museum by his daughter, Miss Theresa F., and his son, William E. Schoenborn.

Miss Irene D. Dobroscky, Assistant Entomologist of the Boyce Thompson Institute for Plant Research, sailed July 6 on the S. S. Tuscania for Plymouth, England. Miss Dobroscky expects to spend three months in Europe and will attend the Zoölogical Congress at Budapest.

Mr. Stanley Garthside, who for the past college year has been attending Cornell University on a scholarship in Forest Entomology from Australia, has been visiting some of the state and Federal entomological laboratories and field stations in the eastern United States.

Dr. Alfons Dampf, Chief Entomologist, and Senor Copel Rivas, Quarantine Officer, of the Mexican Department of Agriculture, en route to the meetings of the Western Plant Quarantine Board meetings at Reno, Nevada, visited a number of Western laboratories and consulted the entomologists and quarantine officers.

The following entomologists recently visited the Boyce Thompson Institute for Plant Research: Mr. Herbert T. Osborn of the United Sugar Company, Las Mochis, Sinaloa, Mexico; Dr. Grace H. Griswold of Cornell University, Ithaca, N. Y.; Mr. D. J. Caffrey and Mr. C. H. Batchelder of the European Corn Borer Laboratory, Arlington, Mass.

Dr. H. W. Allen, of the Japanese Beetle Laboratory, Riverton, N. J., recently visited the Gipsy Moth Laboratory, Melrose Highlands, Mass., and the Corn Borer Laboratory, Arlington, Mass., and on May 17, called at the Connecticut Agricultural Experiment Station, New Haven, Conn., to examine type material in the genus *Tiphia*.

Professor R. A. Wardle of the University of Manchester, England, arrived in the United States recently and took up his work as Associate Professor of Entomology at the University of Minnesota on July 1. Professor Wardle is well known as a co-author of "Principles of Economic Entomology," by Wardle and Buckle.

According to *Science*, the tenth annual meeting of the Northwestern Association of Horticulturists, Entomologists and Plant Pathologists was scheduled to be held at the University of Idaho, Moscow, Idaho, and at the State College of Washington, Pullman, Washington, on June 27, 28, and 29. These two institutions are only nine miles apart.

Professor A. L. Melander, of the College of the City of New York, Mrs. Melander, Professor C. T. Brues, of the Bussey Institute, and Mrs. Brues, visited the Gipsy Moth and Corn Borer Laboratories in April. L. G. Baumhofer, of the Division of Forest Insects, also stopped at the Gipsy Moth Laboratory recently.

The Department of Entomology of the Kansas State Agricultural College has been allotted two acres of ground for experimental work. A two-room house on the ground has been remodeled into a field office and laboratory. A large field insectary has been built and a new cave for the rearing of subterranean insects has been constructed.

Dr. Clarence E. Mickel of the Division of Entomology and Economic Zoölogy at the University of Minnesota, has resigned his position as Extension Entomologist which he has held for the past five years. Beginning July 1, Dr. Mickel will have charge of the insect collections and will teach the courses in general and systematic entomology in the Department of Zoology.

A newspaper dispatch from Danbury, Conn., dated June 22, states that Nicholas Soloman of that city has established a silkworm farm, having brought 20,000 eggs from Syria, his native land, last fall. These he has successfully hatched, and the worms are now nearing the productive period. Mr. Soloman's only difficulty in his novel enterprise has been in finding sufficient mulberry leaves for the worms' diet.

Recent appointments in the Bureau of Entomology are announced as follows: Herbert H. Schwardt, Bentonville, Ark.; Lawrence C. McAlister Jr., Riverton, N. J.; Dean L. Christenson, Salt Lake City, Utah; Glenn C. Barrett, Wichita, Kansas; D. L. Van Dine Jr., Jaronu, Cuba; Charles A. Clark, Arlington, Mass.; Earl G. Davis, Tempe, Ariz.; Howard O. French, Salt Lake City, Utah; J. K. Holloway, M. C. Swingle, E. T. Lundberg, R. W. Burrell, and Max R. Osburn, Riverton, N. J.; Harold H. Shepard, Washington, D. C.; A. Weed, Madison, Wis.

Mr. H. J. MacAloney, of the Harvard Forest Reserve, Amherst, Mass., is spending two months this summer with the Division of Forest Insects, Entomological Branch, coördinating the Branch work on the white pine weevil with the extension investigations being carried out under his direction in the eastern United States. Mr. MacAloney was recently at Fredericton, N. B., and will later continue working in Nova Scotia, Quebec, and Ontario.

According to *Science*, the program of the twelfth assembly of the Czechoslovak Academy of Agriculture, held at Prague on June 11, included a celebration of the seventieth birthday of Dr. L. O. Howard, Chief of the Bureau of Entomology of the U. S. Department of Agriculture. The address was made by Dr. Frantisek Rambonsek, who referred to Dr. Howard's successful activities for the benefit of the agriculture of the whole world.

Dr. R. N. Chapman, Chief of the Division of Entomology and Economic Zoölogy at the University of Minnesota, who is spending his sabbatical year in Europe studying biotic potential, attended the meetings of the French Association for the Advancement of Science at Constantine, North Africa. After the meetings he went on an excursion with the French scientists some one hundred miles into the Sahara Desert, returning by way of Tunis.

Mr. C. H. Curran, of the Entomological Branch, Department of Agriculture, Ottawa, Canada, spent two weeks in April in Washington studying flies in the

National Collection, and collecting in the vicinity of the District. He returned to Canada on April 29. While here, besides consulting with the specialists in the National Museum, he conferred with other members of the Bureau, especially those in the Division of Stored-Product Insect Investigations.

In the interests of Insect Pest Survey work, Mr. J. A. Hyslop made a trip to the Pacific Coast during June, giving talks at the meetings of the Entomological Club of Southern California and the Pacific Slope Branch, at Reno, Nevada. Work on the determination of the actual field population of the alfalfa weevil was carried on at Salt Lake, and of the pepper weevil in Orange County, California.

Dr. S. P. Minkiewicz, Entomologist, Department of Entomology of the Government Institute for Agricultural Research, Bulawly, Poland, visited the Branch headquarters early in May and spent many days conferring with Branch officers. Dr. Minkiewicz is visiting centers of entomological research in various parts of the United States and Canada, securing data on their organization, methods of study, etc. He is chiefly interested in economic entomology, particularly in fruit and field crop investigations.

Recent temporary appointments in the Entomological Branch, Canadian Department of Agriculture, are as follows: W. E. Steenburgh, George Wishart, Chatham, Ont.; R. M. White, Treesbank, Man.; Ellis McMillan, A. P. Arnason, Saskatoon, Sask.; A. C. Pierce, Lethbridge, Alta.; H. H. Ross, Agassiz, B. C.; J. Stanley, Victoria, B. C.; F. Jeffrey, Ottawa; H. B. Stevens, Chatham, Ont.; B. D. Blair, Niagara Falls, Ont.; J. B. Maltais, Hemmingford, Quebec; D. G. Gillespie, Vernon, B. C.; Ernest A. Rendell, Trinity Valley, B. C.; J. R. B. Coleman, Fredericton, N. B.; R. Paradis, Ottawa.

According to the newspapers, Warran Knaus, Editor of the Democrat-Opinion, and Coleopterist, has received the degree of doctor of science from his alma mater, the Kansas State Agricultural College and from McPherson College. Dr. Knaus has a collection of more than 100,000 specimens representing more than 10,000 species of beetles. He is credited with the discovery of at least 100 new species, twenty of which have been named in his honor.

Mr. J. C. Bridwell, who has been in the Orient for the last few years, has returned to America, and visited the Division of Insects on April 29 and 30. Mr. Bridwell brought with him many specimens which he has collected, and has arranged to have forwarded a considerable series of specimens from India. He is primarily interested in completing his studies on Bruchidae (Mylabridae) and is making an effort to find means for continuing them.

On March 23, Oliver I. Snapp gave an address at Clemson College, S. C., on "Insects Attacking the Peach in the South and How to Control Them." Mr. Snapp states that the plum curculio infestation in the Georgia Peach Belt has again become serious. The present infestation is apparently the heaviest that has occurred there in five years. Five bushels of peach drops collected on April 11 have already given up 4,481 curculio larvae.

Mr. A. R. Prince has been appointed Biologist and will have charge of the work in entomology and plant pathology at the Agricultural College, Truro, N. S., in place of Dr. W. H. Brittain, who resigned to become Professor of Entomology at MacDonald College, McGill University. Mr. Prince took his undergraduate work at Acadia

University, Wolfville, N. S., and graduate work in mycology, plant pathology and entomology at Harvard University, and expects to receive a doctor's degree at an early date.

On May 8, Messrs. William Middleton and T. E. Snyder, of the Bureau of Entomology, inspected coniferous timbers recently removed from the roof of the White House. The roof has been so greatly weakened that it had to be replaced. It was found that the timbers of the roof had been powderposted by a Cossonid, *Hexarthrum ulkei* Horn. This insect has caused similar injury to buildings in New York and Washington, and has also damaged flooring in houses in Washington.

Messrs. J. L. King and H. W. Allen, of the Japanese Beetle Laboratory, Riverton, N. J., recently visited the Gipsy Moth Laboratory at Melrose Highlands, and the Corn Borer Laboratory at Arlington, Mass. While there they made a profitable study of the methods used in parasite work at these institutions. Dr. Allen spent a few hours examining type material of North American *Tiphia* in the collections of the Cambridge Museum of Coöperative Zoölogy, as well as in the Connecticut State collection at New Haven.

Mr. H. G. Crawford, Entomological Branch, visited southwestern Ontario and certain corn borer infested sections of the United States from May 28 to June 8, to survey the progress of the corn borer "clean-up" control operations. He motored some five hundred miles through the counties of Norfolk, Oxford, Elgin, Kent, Essex, Lambton, and Middlesex in company with Professor L. Caesar, Provincial Entomologist. His visit to the United States consisted of a three hundred mile tour through western Ohio, and south completely across the infested area, in company with Mr. G. M. Stirrett.

A radio talk entitled "Insect Pests of Haiti," was given in French by Augustin Fabius, and in English by George N. Wolcott, from Station HHK, Port-au-Prince, Haiti, on the evening of June 10, 1927. The almost complete absence of insect pests attacking coffee and logwood, the first and third most valuable export crops, and the practical immunity of the native Haitian cotton from attack by the pink bollworm were the main points emphasized. Sisal, which has recently been extensively planted, is also free from attacks by specific pests. Bananas and sweet potatoes, widely grown for domestic consumption, are, however, seriously injured by *Cosmopolites sordidus* Germar and *Cylas formicarius* F.

Messrs. A. F. Burgess, H. L. Blaisdell, and J. N. Summers of the Bureau of Entomology spent several days in the week of April 25 investigating gipsy moth conditions in the barrier zone and in bordering towns. By previous arrangement Harold L. Bailey, Entomologist of the Vermont Department of Agriculture, was met at Brattleboro, and several bad infestations east of the barrier zone were inspected and arrangements completed for conducting coöperative control work to prevent spread from these colonies. In the course of the trip a conference was held at Rouses Point, N. Y., with Messrs. L. S. McLaine and S. H. Short, of the Entomological Branch, Department of Agriculture, Ottawa, Canada, and the work in the barrier zone and in the Canadian territory was thoroughly discussed.

Professor C. W. Howard, who for the past ten years has been working in the upbuilding of the silk industry of Southern China, is returning from Canton to this country as Head of the Department of Biology at Wheaton College, Wheaton,

Illinois. Beginning his work in the Biology Department of the Canton Christian College, Professor Howard developed the work in Sericulture to such an extent that the Chinese government established the Kwongtung Provincial Bureau for the Improvement of Sericulture under his directorship. In response to the urging of the government officials, he will retain his connection with this work, returning to Canton for summers for the next few years.

Dr. W. E. Britton, John T. Ashworth, and Commissioners E. F. Hall and W. A. Hendrick of Connecticut, visited Bristol County, Massachusetts, on July 12, to view the woodlands defoliated by the gipsy moth. Mr. C. W. Collins of the Gipsy Moth Laboratory, Melrose Highlands, Mass., met the party at Taunton and showed them some of the Federal experimental work. On the same day Mr. Harry B. Weiss with a party from New Jersey visited the same area and were shown about by Mr. S. S. Crossman of the Gipsy Moth Laboratory. In the territory between Taunton, New Bedford and Fall River there are thousands of acres where the woodland is stripped of foliage, some of it appearing as bare as in winter.

The California Spray Chemical Company is financing a scholarship at the Kansas State Agricultural College for the coming year for the testing of "Volck" as an insecticide for certain external parasites of domestic animals. This project is linked up with the Crop Protection Institute, and will be carried through as one of their regular projects. The committee in charge of the work consists of Prof. Roger C. Smith as chairman, Prof. Geo. A. Dean and Dr. E. J. Frick of Kansas State Agricultural College, Dr. F. C. Bishopp of the Bureau of Entomology, and Prof. W. C. O'Kane of Durham, N. H. Mr. Wesley G. Bruce, a graduate of Kansas State Agricultural College with the class of 1920, was selected to carry on this project, and reported to begin the work on June 1st.

An important Oriental peach moth meeting with representatives of canning companies was held at St. Catharines, Ontario, on May 17, Mr. Gibson, the Dominion Entomologist, being in the chair. This meeting was called to arrange for a definite understanding as a result of which boxes and other containers used for peaches would be sterilized before being returned to the growers. Other officers of the Department present at the meeting were: Mr. L. S. McLaine, Chief of the Division of Foreign Pests Suppression, Mr. W. A. Ross, in charge of the Vineland, Ont. laboratory, Mr. R. W. Sheppard, in charge of the Oriental peach moth scouting work, and Mr. C. S. McGillivray of the Division of Meat and Canned Foods of the Health of Animals Branch. Following this meeting, Mr. Gibson, in company with Mr. L. S. McLaine and Dr. S. P. Minkiewicz of Poland, proceeded to Toledo, Ohio, to see some of the results of the clean-up work of the European corn borer. Leaving Ohio, a visit en route was also paid to the Monroe, Michigan, corn borer parasite laboratory, and from Windsor, Ontario, a trip through the area under provincial clean-up regulations was made as far as Chatham. The parasite work at Chatham was looked into and on the following day a brief visit was paid to the Strathroy, Ont., Laboratory and the Western University at London, Ont. On the Saturday following, the Plant Inspection Office at Toronto was visited.

Apicultural Notes

The Arkansas Valley Beekeepers' Association met at Wichita, Kansas, July 26.

Starting at Kaukauna, a bee tour will be held across the state of Wisconsin the week beginning August 15.

Professor Lloyd M. Bertholf has just been given a temporary appointment to return to the Bee Culture Laboratory of the Bureau of Entomology to continue his experiments on the response of the honeybee to lights of various intensities and wave lengths.

Although U. S. standard grades for honey have just been published in Department Circular 410 of the United States Department of Agriculture, reports have been received that use is already being made of them by certain large commercial shippers of honey.

Miss Mary Louise Crossman has been appointed temporary field assistant of the Bee Culture Laboratory, Bureau of Entomology, to assist in bee disease research and in the diagnoses of samples of bee diseases which are sent to the Laboratory from all parts of the country.

The Alabama Beekeepers Association will meet on August 4 and 5 at Auburn, Alabama. Mr. George S. Demuth of *Gleanings in Bee Culture*, will be one of the principal out-of-state speakers, and any visiting beekeepers from any part of the United States will be cordially welcomed at the meetings.

The facilities for research work at the Bee Culture Laboratory, of the Bureau of Entomology, have been considerably augmented by the addition of an entire new bee disease laboratory on the third floor of the present building where diseases pertaining to both brood and adult bees will be studied.

A cabin has been leased in an isolated locality about sixteen miles from Laramie, Wyoming, to serve as temporary headquarters for some flight activity and bee disease work. Mr. W. C. Northrup and Mr. C. Harry Linsley have received temporary appointments as field assistants to assist in this work at the Intermountain Bee Culture Field Station of the Bureau of Entomology.

Two large interstate beekeeping meetings will be held in the Middle West during July and August, one at Omaha and Council Bluffs on July 12 and 13. The first day of the meeting will be held at Omaha; the second day in Council Bluffs, which is just across the river. A great many beekeepers in the immediate surrounding states are expected to attend these meetings.

The second interstate meeting will be held on August 9, 10, and 11 at Hamilton, Illinois. Inasmuch as an excellent program is being arranged, and a great many beekeepers will have the privilege of visiting the manufacturing plant of Dadant and Sons, one of the leading manufacturers of beekeeping supplies in the United States, this meeting will probably be well attended.

A beekeepers' meeting will be held in connection with Farmers' Week in Gainesville, Florida, the second week in August. At this meeting Mr. Harry Laidlaw will give a demonstration of artificial mating of queen bees. This demonstration should be extremely interesting in view of the fact that Mr. Laidlaw has had considerable success in the artificial mating of queen bees without the use of instruments. He is associated in this work with Mr. Charles W. Quinn, the veteran queen-breeder.

Horticultural Inspection Notes

The Western Plant Quarantine Board held its ninth annual conference at Reno, Nevada, on June 21 and 22. A report of the meeting has not yet been received.

Mr. N. Rex Hunt has been placed in charge of the Import Division of the Federal Horticultural Board, taking over the duties of Mr. R. K. Beattie, who has been transferred to the Bureau of Plant Industry.

Dr. R. W. Leiby, of the North Carolina State College of Agriculture, made a brief visit to Washington recently to confer with members of the Federal Horticultural Board relative to the enforcement of the Domestic Narcissus Bulb Quarantine.

Mr. George Becker, in charge of the pink bollworm eradication work of the Federal Horticultural Board, was in Washington during the week of June 20, for a conference relative to further work on the pink bollworm and the Thurberia weevil.

Mr. James Zetek, who has charge of the horticultural inspection in the Canal Zone, has been temporarily transferred to Brownsville, Texas, to assist in the clean-up work being carried on in that region in an attempt to eradicate the Mexican fruit fly.

Mr. Noel F. Thompson, who was formerly employed by the U. S. Department of Agriculture, Office of Cereal Crops and Diseases of the Bureau of Plant Industry, has been appointed associate plant pathologist of Wisconsin. Mr. Thompson will be in charge of the bulb and raspberry inspection.

Dr. S. B. Fracker, State Entomologist of Wisconsin, resigned his position with that state to accept an appointment with the Federal Horticultural Board as Senior Plant Quarantine Administrator. He reported in Washington for duty on June 16 to take charge of the enforcement of domestic quarantines.

The funds of the Minnesota State Nursery Inspection Service have been increased from $8,000 to $10,000 per annum. At the same time the fees for inspection have been increased so that the general nursery pays $25, the small fruit grower selling stock, $15, and those selling only raspberries and evergreens, $10 per annum.

Mr. C. E. Cooley, who is in charge of the work of the Federal Horticultural Board in Porto Rico, was in Washington for a few days recently for a conference relative to his work on the Island. Mr. Carlos Chardon, Commissioner of Agriculture of Porto Rico, was also in Washington at the same time to discuss quarantine and inspection problems.

Mr. E. L. Chambers, who was at one time employed in the Bureau of Entomology, has been selected to fill the position of state entomologist and plant pathologist of Wisconsin recently vacated by the resignation of Dr. S. B. Fracker. Mr. Chambers will have charge of the plant quarantine work for the State, as well as the work on entomology and pathology.

A public hearing was held by the Federal Horticultural Board in Washington on June 20, relative to the recent outbreak of the Mexican fruit fly, *Anastrepha ludens*, Loew, in the delta region of the Rio Grande River. The states of Texas, California, and Florida were well represented at the hearing. Among those present were Messrs. R. E. McDonald and J. M. Del Curto of Texas, Lee A. Strong of California, and J. H. Montgomery of Florida.

At a conference held at the Department of Agriculture on June 22 to consider the necessity of placing restrictions on the movement of green corn within the area now quarantined on account of the European corn borer, it was decided that such action is not warranted at the present time. The conference was called and presided over by Dr. C. L. Marlatt, Chairman of the Federal Horticultural Board. Opportunity was given for those present to state their views on the subject, and communications from interested persons not present were read and discussed. After a thorough consideration of the various points of view, it was deemed unnecessary, at the present time, to place any restrictions on the movement of green corn within the quarantined area.

Notes on Medical Entomology

Mr. W. E. Dove, who resigned from the Bureau of Entomology last October to pursue graduate studies at John Hopkins University, was reappointed in the Bureau of Entomology on June 1. He will continue investigational work on insects which affect livestock, with headquarters at Dallas, Texas.

Mr. H. M. Brundrett, Professor of Horticulture at John Tarleton Junior Agricultural College, Stephenville, Texas, has been appointed by the Bureau of Entomology for work at Dallas, Texas, during the summer season. He will continue investigations begun by him two years ago of sprays against flies which affect livestock.

Dr. Karl Jordan, Curator of the Tring Museum, England, spent most of the month of May at the U. S. National Museum, studying the collection of fleas. Dr. Jordan is preparing a monograph of the fleas of the world as a memorial to the late Honorable N. Charles Rothschild, who was for many years an associate of Dr. Jordan in his work on the fleas. While in Washington Dr. Jordan called on a number of scientific men whose acquaintance he had made abroad.

Largely owing to the initiative of the Dominion Entomologist, an organization known as the Mosquito Control Committee of the Ottawa District has been formed in Ottawa, and sufficient funds secured to carry on a comprehensive control campaign against local mosquitoes. The Committee, which is functioning under the chairmanship of Dr. R. E. Wodehouse, of the Canadian Tuberculosis Association, is made up of official representatives of local municipalities and Messrs. Arthur Gibson (who is acting as secretary) and C. R. Twinn, of the Entomological Branch. Oiling operations have been in progress since the end of April under the field direction of Mr. Twinn and were completed early in June. Although mosquitoes are proving a severe pest in many sections of Canada, because of the unusually extensive rains which fell during May, the residents of Ottawa and neighboring municipalities are enjoying comparative immunity as a direct and gratifying result of the control operations.